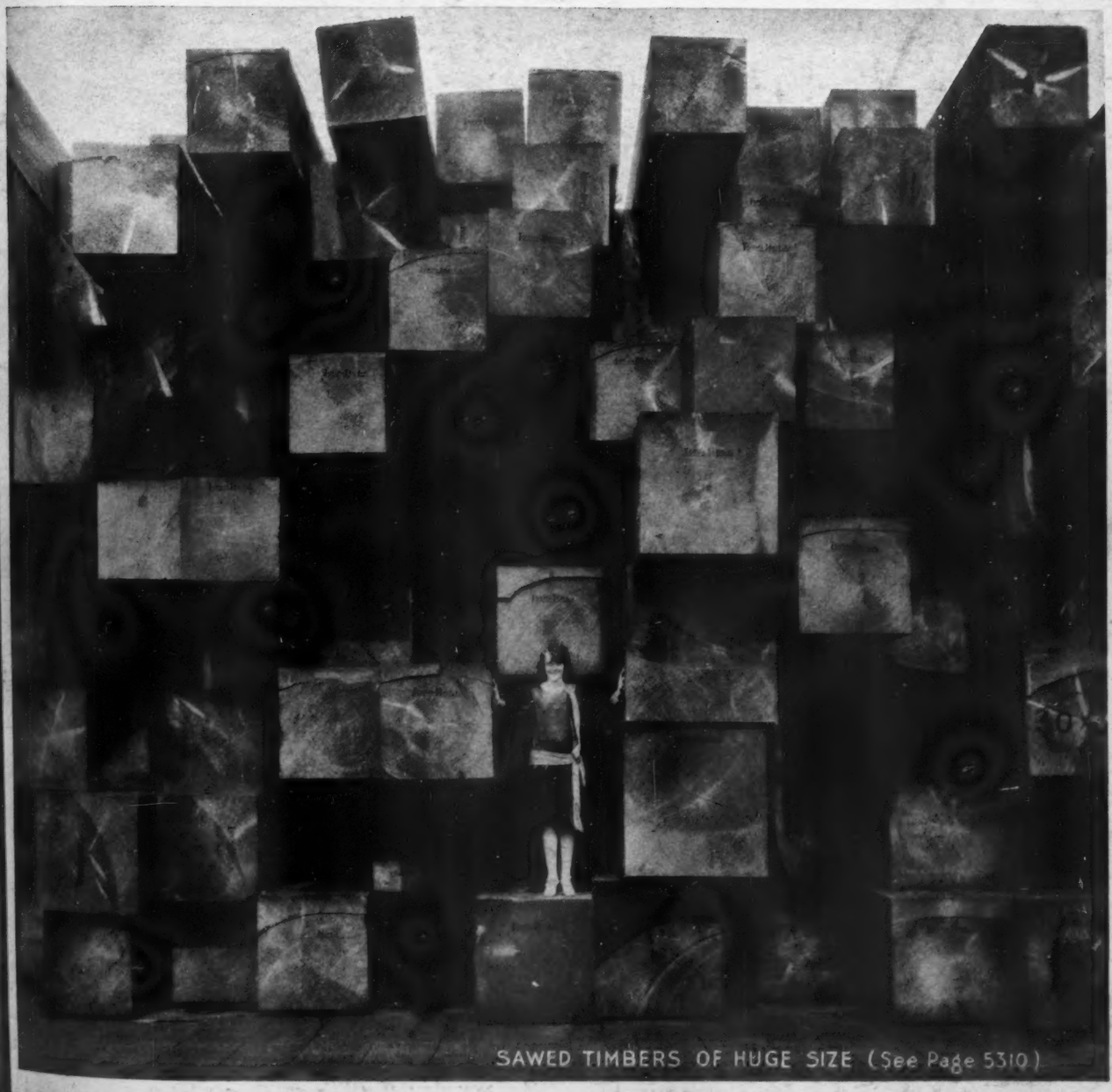
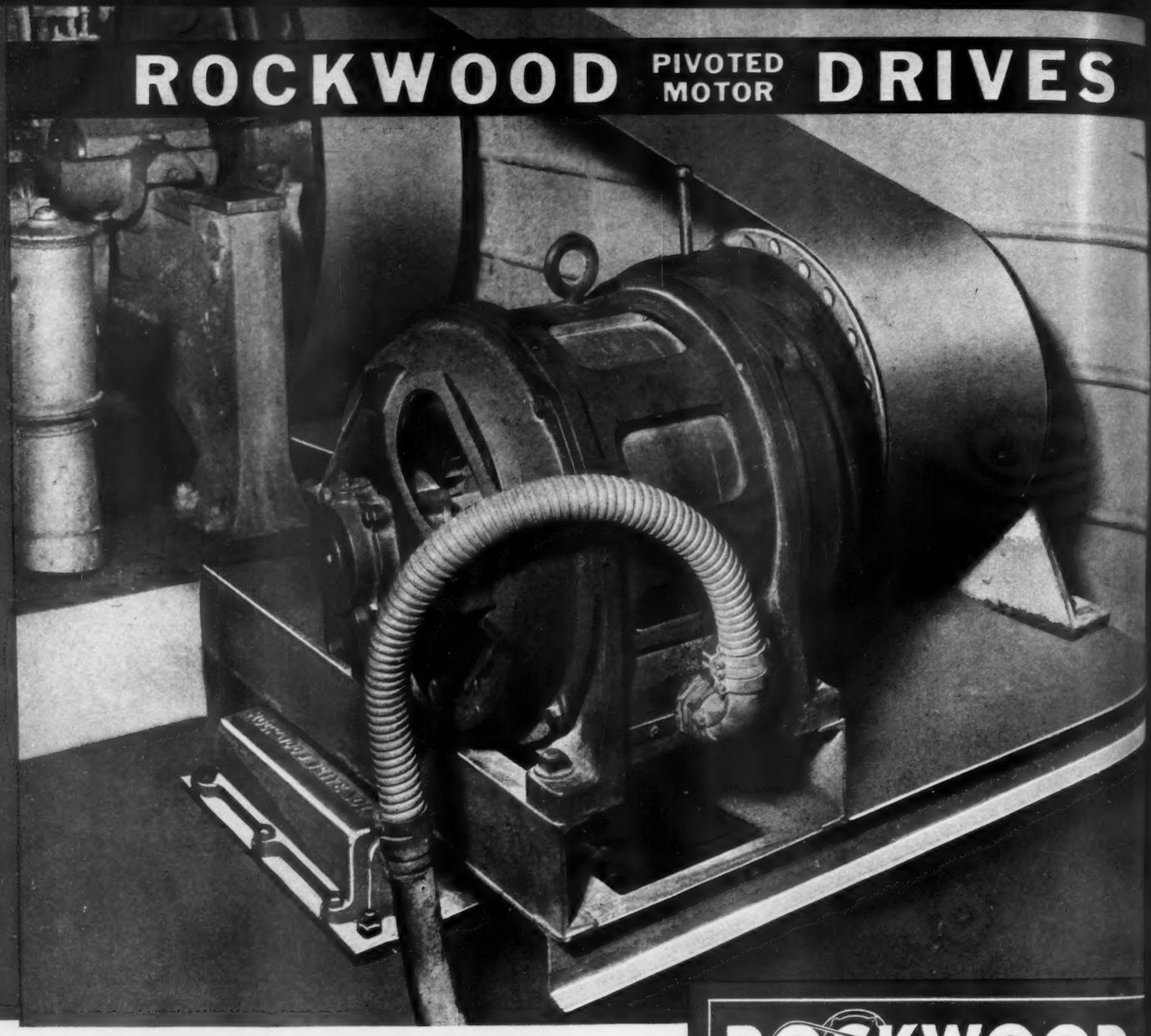
Compressed Air Magazine

Vol. 42, No. 5 | London - New York - Paris | May, 1937



SAWED TIMBERS OF HUGE SIZE (See Page 5310)

ROCKWOOD PIVOTED MOTOR DRIVES



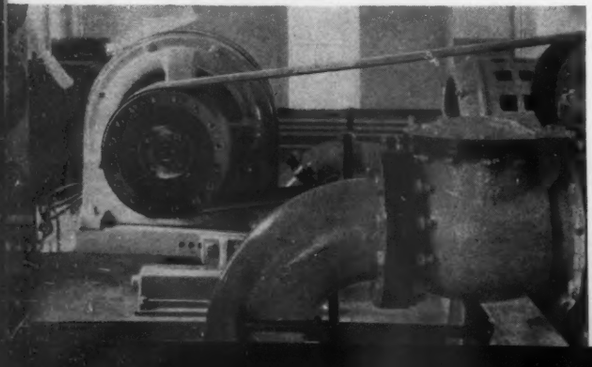
improving performance reducing maintenance,

For the first time makes short center drives truly satisfactory . . . No other motor drive offers so many advantages.

ROCKWOOD PIVOTED MOTOR DRIVES WILL SAVE YOU MONEY BECAUSE THEY AUTOMATICALLY MAINTAIN BELT TENSIONS
OVER 50,000 IN SUCCESSFUL USE

The above Rockwood Drive is used with a 75 h.p. back-geared motor driving a paper mill beater—noted for its high starting and peak loads. In mill of Beveridge Paper Company, Indianapolis, Indiana, where it has operated 24 hours a day, six days a week for four years. This mill is now putting in three duplicate drives to new beaters being installed which certainly speaks well for the satisfactory performance they have had. Paper mills are going to Rockwood Drives in a big way—finding them superi all kinds of machine drives—beaters, pumps, Jordans, compressors and others. Wherever used—with large or small motors—incre output is assured as the Rockwood Drive delivers maximum dependable pow that driven pulley *speeds are maintained.* Power is saved—due to higher sust efficiencies—*higher than for other drives.* The Rockwood Drive is its own m tenance man—the bother and expense of drive *take ups are practically elim ated.* Belt life is *often doubled.*

100 h. p. Rockwood Drive with a Gould centrifugal pump. Capacity 1,000 gallons per minute, Lebanon Water Works, Lebanon, New Hampshire.



Wherever you have WORK to be done, machines where you want *maxim output at minimum cost*—or where you want drives with as little maintena as possible THE ROCKWOOD DRIVE—COMBINED WITH THE EQUALLED PULLING SURFACE OF ROCKWOOD waterproof PULL —WILL GIVE YOU TRULY SATISFACTORY SHORT CENTER MO DRIVES.

Write for a Rockwood recommendation for your machinery drives. Yo put one in *on trial* if you desire. With all their marked advantages th cost is frequently less than for other drives.

ROCKWOOD MANUFACTURING COMPAN
Indianapolis, Indiana, U. S. A.

ACKNOWLEDGEMENT

THE POEM by Mrs. Gladys Craig Potter that is published on page 5330 originally appeared in *California Highways and Public Works* and is reproduced by permission of the editor of that publication. Possibly it voices the sentiments that many wives of engineers have often wanted to express.

•

IN THIS ISSUE

SELDOM have we printed a more readable or a more informative article than that by Henry W. Young descriptive of the Long-Bell Lumber Company's sawmill at Longview, Wash., the largest plant of its kind in existence. Steam formerly reigned supreme in sawmills; but the experiences of this concern have shown that virtually all the operations can be performed to greater advantage with compressed air. As the author points out, steam barely gets past the front door at Longview. After that air takes command.

•

ALTHOUGH they are familiar structures, bridges never seem to lose their fascination. Huge bridges have been following one another with regularity in this country in recent years, and we have become accustomed to reading about gargantuan spans. Europe's longest bridge forms an important link in the rail-water route between Denmark and Germany, and was opened to traffic last December. The unusual and interesting methods which were used in sinking caissons within which to erect the numerous supporting piers are described by Robert G. Skerrett.

•

FOR NEARLY 30 years, a wooden flume has carried water from the Stanislaus River in California to a 45,000-hp. hydroelectric plant owned and operated by the Pacific Gas & Electric Company. Periodically, however, Nature went on the rampage and swept away sections of the conduit, with the result that service was interrupted and expensive repairs had to be made. The flume is now being replaced by an 11-mile tunnel that is being driven through solid rock and will therefore not be subject to surface disturbances. The general features of the undertaking are covered in an article by R. O. McGougan, who is connected with the utility company.

•

MOST of us know little about the vast country that borders the United States on the north. *"Down North" on the McKenzie River* contrasts past and present methods of travel on one of the world's greatest waterways.

Compressed Air Magazine

Copyright 1937 by Compressed Air Magazine Company

Volume 42 **MAY, 1937** **Number 5**

C. H. VIVIAN, *Editor* J. W. YOUNG, *Advertising Manager*
A. M. HOFFMANN, *Assistant Editor* J. F. KENNEY, *Business Manager*
D. Y. MARSHALL, *European Correspondent*, 243 Upper Thames St., London, E. C. 4
F. A. McLEAN, *Canadian Correspondent*, New Birks Bldg., Montreal, Quebec.

EDITORIAL CONTENTS

Compressed Air in a Super Sawmill—Henry W. Young 5310
The Longest Bridge in Europe—Robert G. Skerrett 5319
Pacific Utility Driving 11-Mile Tunnel—R. O. McGougan 5325
"Down North" on the McKenzie River 5328
Mining Industry on Canvas 5329
Compressed Air from the Sea 5329
Vacation with an Engineer—Gladys Craig Potter 5330
Editorials—The Highway Diesel—Homage to an Engineer 5331
Air Gun Sprays Rubber Sealing Rings on Tin Cans 5332
Pneumatic Micrometer Checks Accuracy of Borings 5332
When Rock Crushed Rock 5332
Adaptable Pneumatic Marking Machine 5333
Compressed Air Purges Soil of Gas 5333
Keep Boiler Tubes Clean 5333
Oil-Burner Blower Effects Savings in Operating Costs 5334
New Stope-Filling Materials and Method 5334
Driving Golden Rivet in Golden Gate Bridge 5334
Industrial Notes 5335

ADVERTISING INDEX

Allis-Chalmers Mfg. Co. . Back Cover
American Air Filter Co., Inc. 24
American Brass Co., The 25
Bethlehem Steel Co. 10
Bucyrus-Erie 26
Burgess Battery Co. 30
Combustion Engineering Co., Inc. 20
Compressed Air Magazine Co. 23
Dayton Rubber Mfg. Co. The Insert page 4
Direct Separator Co., Inc., The ... 23
General Electric 19
Goodrich Co., The B. F. 13
Greene, Tweed & Co. 30
Hercules Powder Co. 22
Houghton & Co., E. F. 18
Ingersoll-Rand Co. 6-15-27
Jarecki Manufacturing Co. 31
Jenkins Bros. 17
Maxim Silencer Co., The 31
National Forge & Ordnance Co. Insert page 3
New Jersey Meter Co. 31
Norton Company 12
Rockwood Manufacturing Co. Second Cover
Socony-Vacuum Oil Co., Inc. Insert pages 1-2
S K F Steels, Inc. 14
Staynew Filter Corporation 3
Texas Co. The 4-5
Timken Roller Bearing Co., The .. 7
United States Rubber Co. 28
Vogt Machine Co., Inc., Henry ... 16
Waukesha Motor Co. 29
Westinghouse Elec. & Mfg. Co. .. 8-9

A monthly publication devoted to the many fields of endeavor in which compressed air serves useful purposes. Founded in 1896.

Published by Compressed Air Magazine Company. G. W. MORRISON, president; R. A. LUNDELL, vice-president; F. E. KUTZ, secretary-treasurer.
Business, editorial, and publication offices, Phillipsburg, N. J.
Advertising Office, 11 Broadway, New York, N. Y.
Annual subscription price: domestic, $3.00; foreign, $3.50. Single copies, 35 cents.
Compressed Air Magazine is on file in many libraries and is indexed in Industrial Arts Index.

THE LOG POND

This basin is more than 1½ miles long. Logs hauled from the forests by 40- to 55-car trains are dumped into it and floated or towed by a tug to the area shown above. From there they are hauled up the incline, in the middle, by a chain conveyor and, after being scaled at the door, enter the second story of the mill. *En route* they pass through a series of high-pressure water jets visible to the right of the white building in the center.

THE MILL FROM THE AIR

In the foreground is Longview, a preplanned city of 15,000 persons. Beyond it is the mill, divided into east and west sides. Between them is the log pond, and to its right the power house. This is the largest lumber mill in existence.

LONGVIEW, WASH., a preplanned city, was conceived less than twenty years ago by executive minds in the nationally known Long-Bell Lumber Company, and was embodied in their plans for the world's largest lumber mill beside the deep waters of the Columbia River. It is located 50 miles inland from the Pacific Ocean, with dock facilities accommodating the largest ocean steamers, is 50 miles northwest of Portland, Ore., and 150 miles south of Seattle, Wash. Within the space of ten years after its founding in a peaceful valley of farms, this model city contained 2,700 permanent homes, 75 apartment buildings, 160 acres of parks, and some 15,000 inhabitants.

The Long-Bell plant stands today, thirteen years after the first saws turned, as a marvel of mechanical efficiency in the conversion of fir, hemlock, and cedar logs into timbers and finished lumber, and even into certain manufactured products such as

ON THE WAITING LIST

After entering the mill by way of the incline from the log pond, the logs are rolled on to a sloping deck, where they are held back by loader arms. Waiting for them is the saw carriage, which may be seen at the left bearing a partly sawed log.

Compressed Air in a Super Sawmill

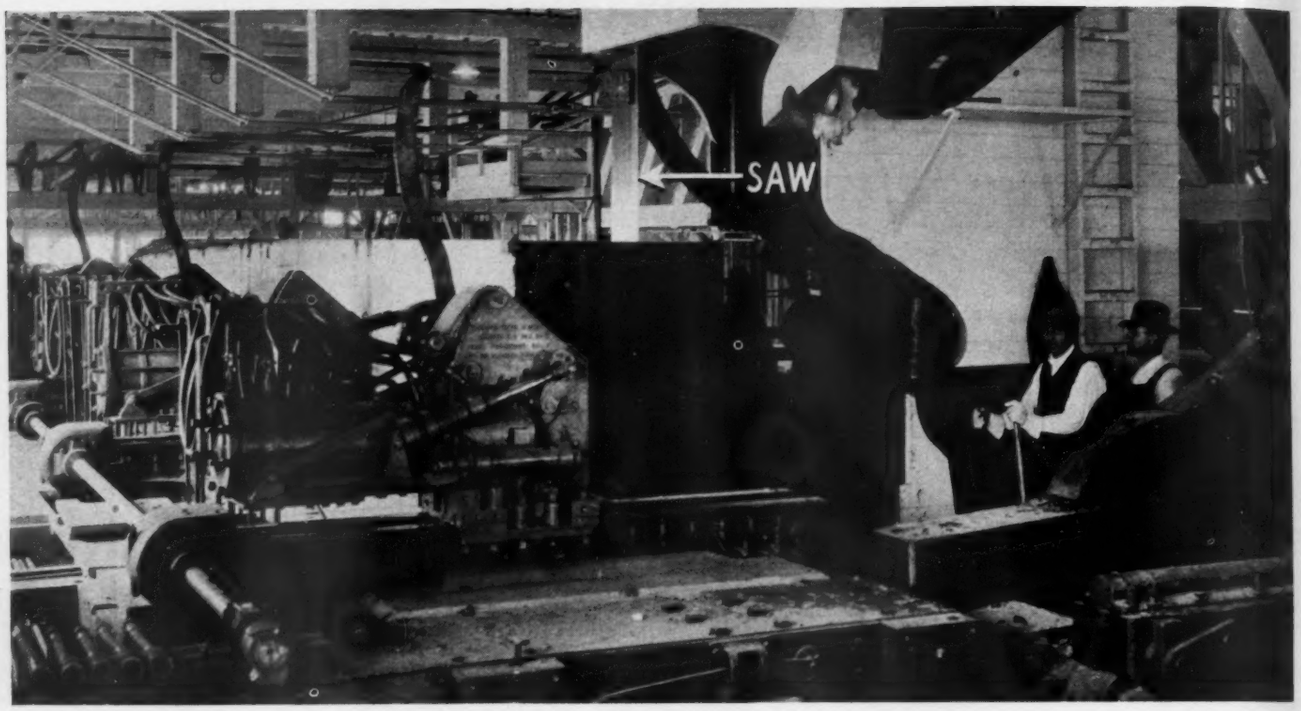
Henry W. Young

window frames, door stock, household furniture, etc. In it was incorporated all the best in sawmill practice that had gone before, and much besides. All the operations were designed to be as nearly automatic as possible. As a result, production on an unheard of scale is achieved. The mill, or rather mills, for there are two distinct units, can and does turn out an average of 125,000 board feet of lumber per hour. Working two 8-hour shifts, this means 2,000,000 board feet per day. With good timber and favorable operating conditions, production has been stepped up to as much as 130,000 board feet per hour. Pencil pushers with a mathematical turn of mind have no doubt already determined that all the output, if it were to be reduced to 1-inch boards a foot wide, would be coming out of the mill at the rate of 2,000 lineal feet per minute, and that in one day's time, with two 8-hour shifts, the tongue of boards would extend beyond the limits of the plant for a distance exceeding 23 miles!

The east group of buildings comprises 37 acres under roof; the west group 38 acres. In addition, there are many acres of timber docks where green lumber is stored for shipment by rail or water. There are 68 great dry kilns in which lumber is dried scientifically for manufacturing purposes, their combined capacity at one charge being 136 carloads. Electric power for running the mill, as well as furnishing steam to the head rigs, called for a plant of major proportions. This was erected on the site. Later on, it was sold to public-utility interests, which now operate it as a utility, providing power not only for the Long-Bell mill but also for the City of Longview and a considerable area around it.

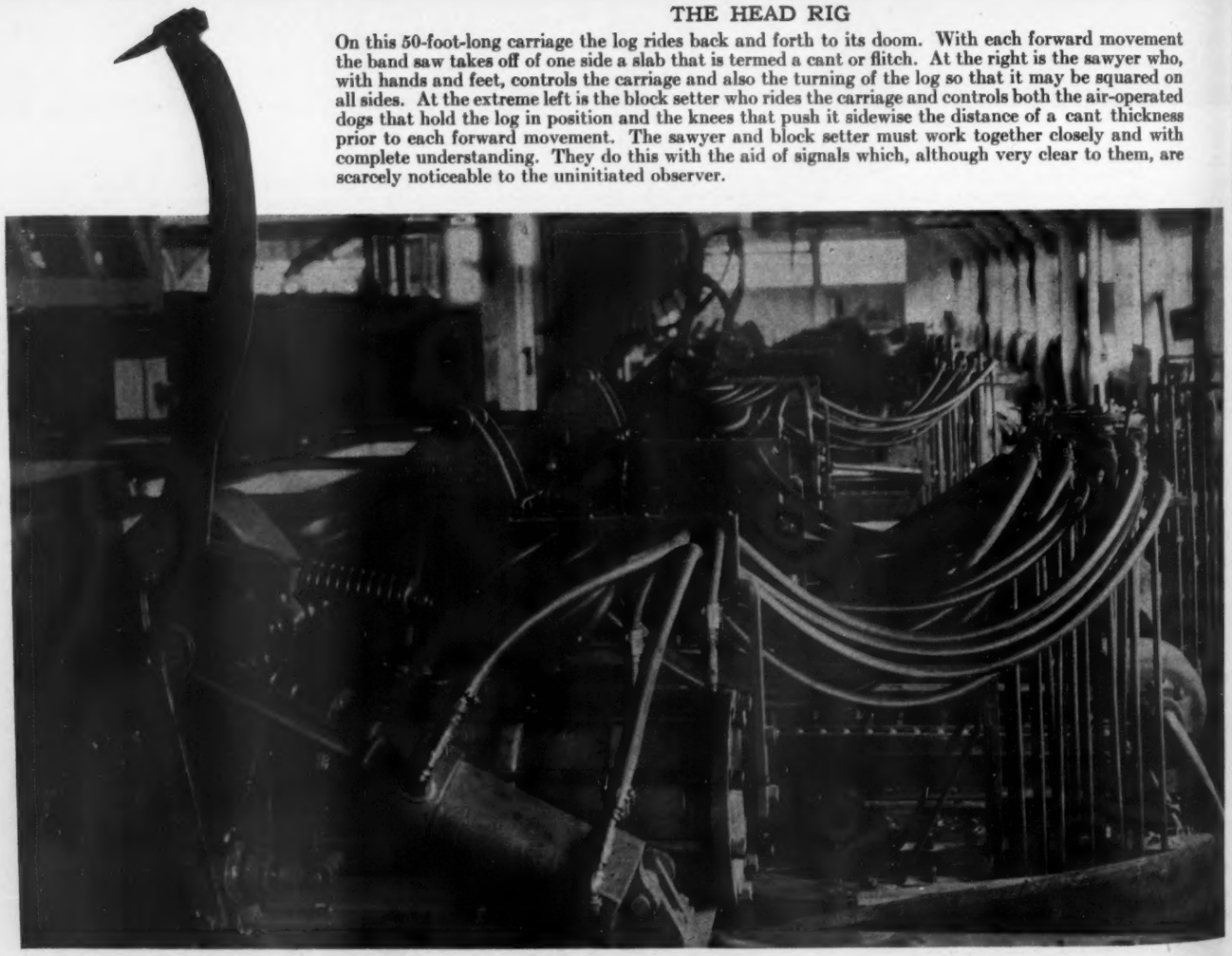
Steam was once the sole motive power in the operation of sawmills. It can be remembered when they were generally referred to as steam sawmills. Even after electric motors began to do much of the work, steam continued to be employed in many ways. In designing the Long-Bell plant, however, it was decided to break away from steam so far as possible. In fact, steam barely gets past the front door into the head rigs. After that, all the heavy lifting, pushing, turning, and squeezing, if such homely phraseology may be permitted, is done by compressed air. In this matter of nearly 100 per cent operation by air, the mill is of distinctive design.

Speaking on this subject, C. A. Huffman, construction engineer of the Long-Bell Company, has said: "I have often tried to visualize what things would be like if we had used steam instead of air for all the various operations. Why, on a cold morning, this whole valley would be in a steam cloud from the hundreds of exhausts. In using air, we transmit it a maximum distance of 2,700 feet from the compressor plant, and maintain it at 80 pounds pressure at the most distant points. Think of



THE HEAD RIG

On this 50-foot-long carriage the log rides back and forth to its doom. With each forward movement the band saw takes off of one side a slab that is termed a cant or flitch. At the right is the sawyer who, with hands and feet, controls the carriage and also the turning of the log so that it may be squared on all sides. At the extreme left is the block setter who rides the carriage and controls both the air-operated dogs that hold the log in position and the knees that push it sidewise the distance of a cant thickness prior to each forward movement. The sawyer and block setter must work together closely and with complete understanding. They do this with the aid of signals which, although very clear to them, are scarcely noticeable to the uninitiated observer.



DOGS AND KNEES

This apparent snarl of pipes and tubes conveys compressed air to the multiplicity of cylinders that operate the boss dogs and hook dogs, that hold the log secure on the saw carriage, as well as the knees that move it sidewise between cuts of cants.

the heat loss in transmitting steam that distance and branching it out all over the plant! It would be water by the time it got there unless the most elaborate and costly insulating system were to be employed. Moreover, the exhausts cause damage. During last winter's exceptionally cold spell, steam exhausted from the head rigs condensed on two motors and ruined them —$500 gone up in steam."

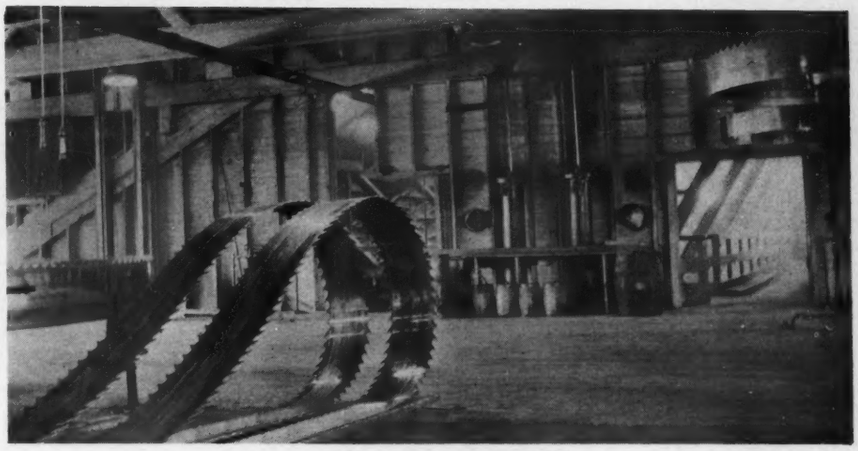
It would be difficult to enter into a detailed, technical description of the extensive and intricate system of compressed-air production and application in a single article. Indeed, so large is the "acreage" of the plant that two days' time spent there would be barely sufficient to stroll over the place to spot the highlights and to give a fairly coherent general outline of them. The following, therefore, must be considered in the nature of a rough sketch rather than a finished drawing.

What are the major applications of compressed air? Where are they, and how many are required? What is the character of the compressor plant? Instead of piecing together paragraph upon paragraph of descriptive matter on these three phases, an attempt has been made to visualize them by means of the accompanying schematic diagram and tabulation. Time will then be left to take a brief journey through parts of the plant and to see where air is at work.

Here is a compressed-air plant, Ingersoll-Rand equipped throughout, having a total capacity of 9,200 cubic feet of free air per minute, exclusive of the emergency belt-driven unit which takes care of the service requirements when the sawmills are down. From the log slip, where the pond man blows his air whistle to start or stop the log haul, on through to the farthest end of the plant, compressed air is employed. While many of the uses of air listed in the tabulation will be taken up more in detail farther on, there are one or two that may be mentioned at this point.

For instance, there are hundreds of air-clean-up stations throughout the buildings and out on the dock. In sawmill operations, a great deal of dust accumulates not only on the floors but on every beam and rafter, in every nook and corner. This dust represents a fire hazard and must be blown down periodically, in some places as often as several times a week. Since the buildings are unheated, and freezing weather occurs occasionally, the sprinkler system is of the dry type. This calls for air pressure, which is required to hold back the water from the sprinkler pipes and heads.

It is evident that in order to maintain these various stations, as well as to operate the moving equipment by means of air cylinders and pistons, the distribution network must cover practically the whole plant. As will be seen by the diagram, two 6x18-foot receivers are located just outside the compressor plant. There are others, however, at more distant points, one being in each of the two sawmill units. A 10-inch pipe, with a few intermediate take-off

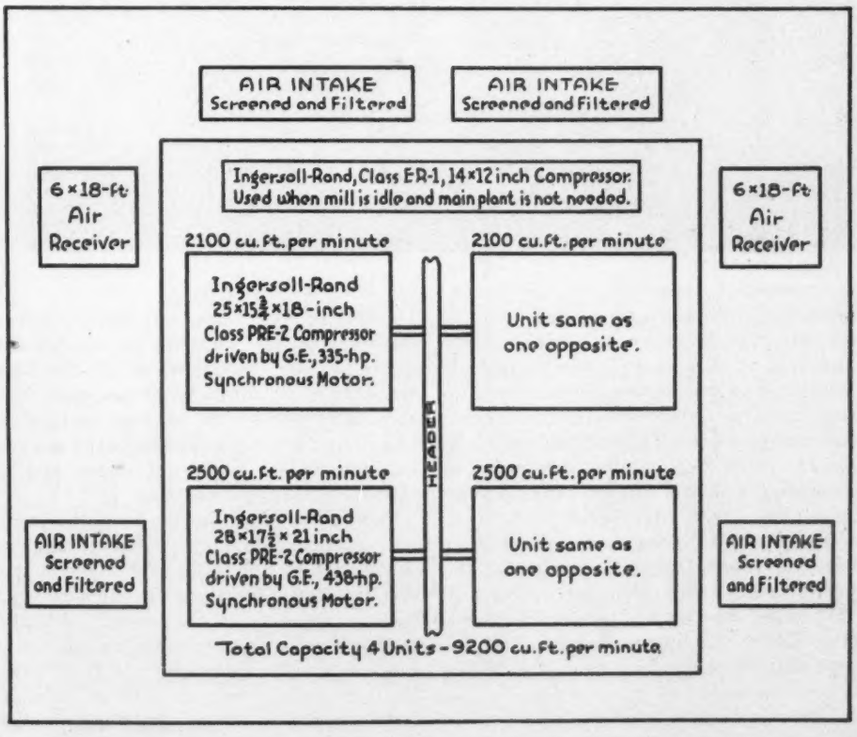


SAW-FILING ROOM

This is directly above the head rig. Saws are pulled from the wheels and brought up for sharpening by the air-cylinder hoists along the far wall.

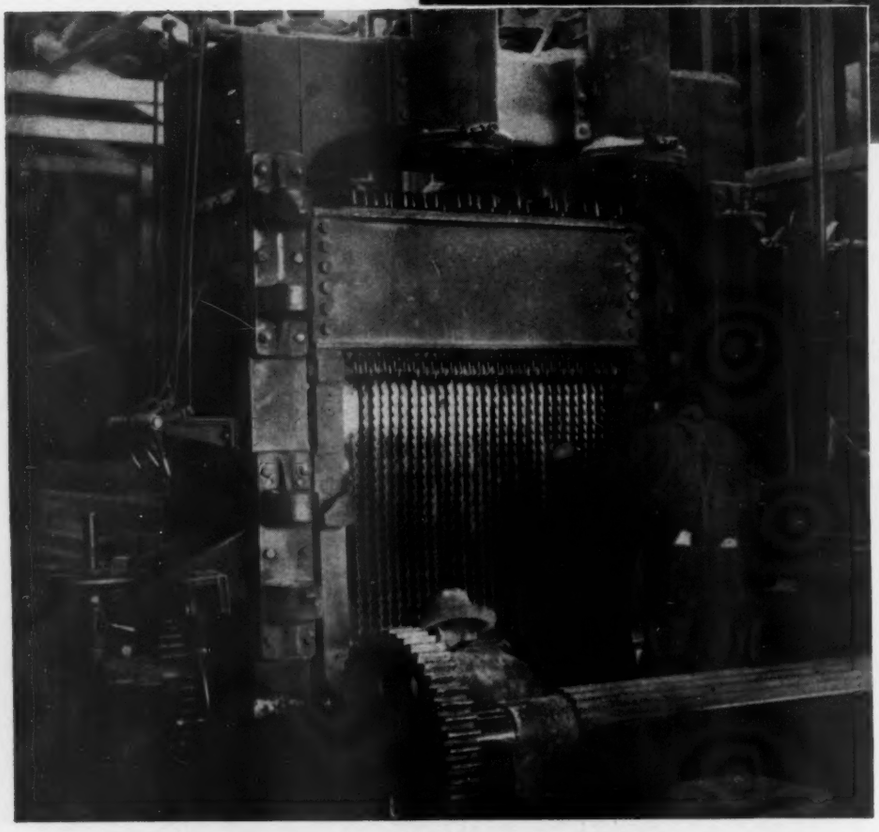
Number and Locations of Air Cylinders		Principal Uses of Compressed Air
EAST MILL		Operating dogs on saw carriages
Skid chains and bumpers	51	Rollway log bumpers or stops
Head rigs, saw hoists, and trimmer saws	161	Skid-chain lifts
		Trimmer-saw lifts
WEST MILL		Timber-butting saws
Skid chains and bumpers	29	Press rolls on bull edgers
Head rigs, saw hoists, and trimmer saws	151	Hoists, including saw hoists to filing rooms
Re-saw mill	119	Air swedges in filing rooms
		Elevating re-saw tables
TIMBER DOCK		Press roll on gang saws
Skid-chain lifters	47	Temperature-humidity control of dry kilns
Total	558	Force lubrication of saw arbors
		Repressuring dry-sprinkler systems
		General cleaning
		Blowing signal whistles

COMPRESSOR PLANT THAT SUPPLIES AIR FOR THESE SERVICES


AIR INTAKE
Screened and Filtered
AIR INTAKE
Screened and Filtered
Ingersoll-Rand, Class ER-1, 14×12 inch Compressor.
Used when mill is idle and main plant is not needed.
6×18-ft. Air Receiver
6×18-ft. Air Receiver
2100 cu. ft. per minute
2100 cu. ft. per minute
Ingersoll-Rand 25×15¾×18-inch Class PRE-Z Compressor driven by G.E., 335-hp. Synchronous Motor.
Unit same as one opposite.
HEADER
2500 cu. ft. per minute
2500 cu. ft. per minute
Ingersoll-Rand 28×17½×21 inch Class PRE-Z Compressor driven by G.E., 438-hp. Synchronous Motor.
Unit same as one opposite.
AIR INTAKE Screened and Filtered
AIR INTAKE Screened and Filtered
Total Capacity 4 Units - 9200 cu. ft. per minute

THE SAW DENTIST

As a band saw wears down, its teeth must be periodically swedged to make their cutting edges wider and thinner than their shanks and thus prevent binding. The swedging is done by this air-operated machine, which squeezes the teeth sufficiently to cause the metal to flow.



TUNING UP A GANG SAW

The workman (left) is rearranging the vertical blades that speedily reduce cants to small-section lumber such as 2x6's. Gripped tightly between rollers, a timber is fed, end foremost, against the rapidly moving saws, which are spaced 2 inches apart. It comes out at the other side cut into the desired dimensions, except as to length. Some of the gang saws have as many as 37 blades.

COMPRESSOR PLANT

This plant (right) has a capacity of nearly 10,000 cubic feet of free air per minute. The four large duplex, electrically driven units carry the load when the mill is operating. The smaller belt-driven, single-stage machine against the wall at the left is used for maintenance work when the mill is idle. At the lower right are shown one of the two air receivers and compressor intake filters.

pipes, leads from the main receivers to these secondary receivers, from which service lines lead to all points. These range from ½ inch up to 6 inches in diameter, and include most of the pipe sizes in between. For each compressor unit there is an air intake placed outside the building, screened, and containing a filter of fine steel wool heavily impregnated with sticky oil.

To follow the course of some of these air lines, the reader will be taken through the west-side mill only. Here the largest logs are handled, and the equipment, in general, is similar to that in the east-side mill, except that there are four head rigs in the latter as against two in the other.

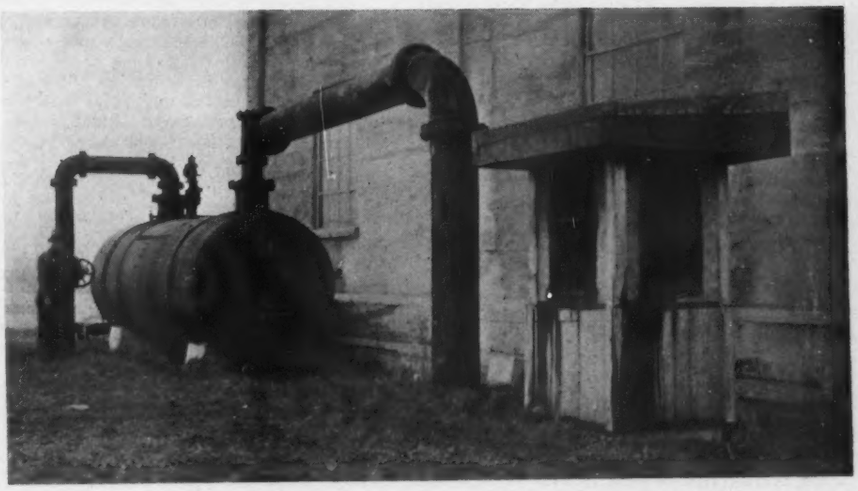
Few machinery operations are more fascinating to watch than those at the head rig of a super sawmill. Greater weights are handled in steel mills, but more ponderously and slower. Here the movements are lightning fast, though some of the logs weigh from 40,000 to 50,000 pounds. Yet they are tossed on the carriage, and rolled and flipped about as quickly as the sawyer can manipulate a pair of levers and a couple of foot-pedal controls.

Logs come up an incline from the pond on a chain or log haul, passing through a spray of water that washes off much of the dirt and sand. They enter the second story, and are rolled on to an inclined log deck. On the way in, however, they pause for a few moments at the door to be scaled. Some have banged-up ends, so a 9-foot circular cut-off saw drops down and neatly snips them off. Several logs can lie side by side on the inclined deck, where they are held back by loader arms. From there they are released, one at a time, and roll down to the carriage.

Upon its arrival, massive push arms rise up and shove the log on to the carriage and up against its vertical "knees." Perhaps it does not lie just right in the opinion of the sawyer. Another lever is pushed, and huge bull hooks reach up from between the arms and turn it over. Still it may not suit the sawyer, so he kicks the foot levers, and up from below comes a vertical ram called the "nigger." This ram is raised and lowered by the pistons of two steam cylinders at the ends of a crossarm, to the middle of which the lower end of the nigger is linked. The pistons operate independently, and one of the cylinders is mounted on a trunnion. Considerable play is therefore given

to the nigger. It can butt the log in the middle and throw it straight up, or the toothed sides of the nigger head can catch it and give it a roll. If you were to take a long-handled garden rake and attempt to dislodge a bird's nest straight above you in a tree by butting it and clawing it with the head of the rake, you would be using a principle similar to that upon which the nigger works. The push arms and hooks just referred to, taken together, constitute what is known as the Simonsen log turner. Between the log turner and the nigger, the sawyer has complete control and handles a log as easily as you would a stick of firewood.

Suppose that the log is now correctly positioned on the carriage, and up against the vertical knees. It must be held there



TRIMMER SAWS

From the gang saw, timbers move on chain conveyors to this assembly of 24 circular saws. Each saw is held up by a piston in a compressed-air cylinder. From a cabin above, the operator (inset) scans the pieces as they approach the poised saws. In front of him are 24 levers, each of which, through the medium of a wire, controls the lowering of one of the saws. It is his job to cut the timbers into standard lengths, to cull out a bad spot here and there, or perhaps to take off one end only. He makes decisions instantly, and his hands play upon the bank of levers with the dexterity and accuracy of a concert pianist.

securely. Out from the knees come boss dogs—steel teeth opposed to each other like the teeth of a beaver—and seize it on the sides. Over the middle of the carriage then appear the hook dogs, which seize the log on top and pull inward and downward against the knees.

The carriage, with the log projecting slightly over the side, is now ready to move forward, its travel being controlled by the sawyer. As the end of the log comes against a vertical band saw, a slab, known as a cant or a flitch, is taken off and the carriage reversed. That done, the knees are pushed forward the requisite amount to project the log again over the side of the carriage so that another cant can be cut off. The carriage is about 50 feet in length, and even has a trailer so that it can handle extra long logs, though the weight of the trailer is not dragged back and forth ordinarily.

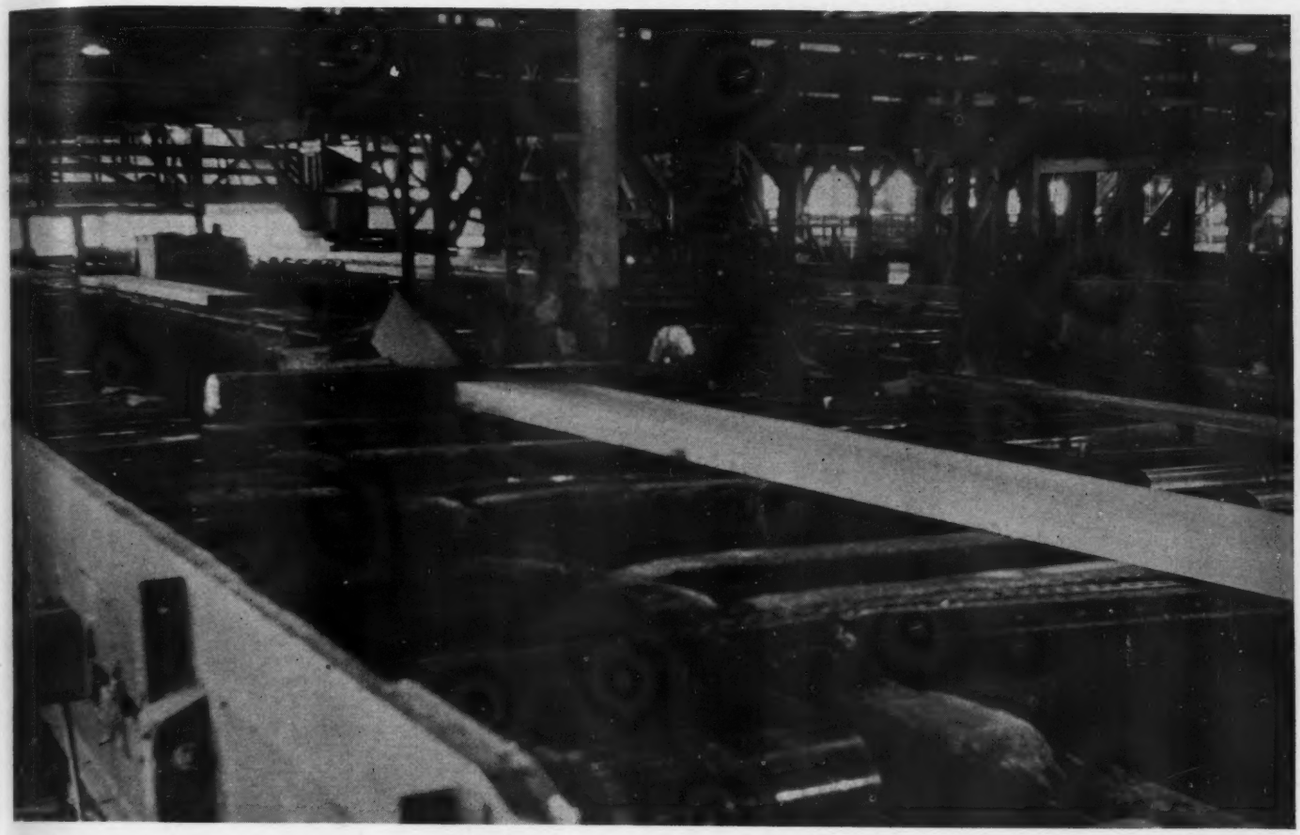
Operation of the boss dogs and the hook dogs, and the movement of the knees back and forth across the carriage, are effected by means of compressed air electrically controlled by push buttons. These controls are handled by a man who rides the carriage and who is called the block setter. His seat is in the midst of an apparent snarl of air lines, each leading to its individual dog or knee cylinder. The mass has all the appearance of an octopus.

Block setter and sawyer must work together as a team. The placing of a log, grasping and holding it, and the forward movement of the knees to push it out the distance of one cant thickness each time, are accomplished in a matter of seconds. Every movement must be exactly timed, and the sequence must be right, or else there will be a major catastrophe at the head rig. These men can coöperate only after considerable practice. They follow a code of signals—a nod of the head, a shrug of the shoulder scarcely noticeable to a bystander. A good sawyer and a good block setter who have not previously worked together must first practice and get their signals so well established that they respond to them well-nigh subconsciously.

When cants are taken off the side of a log and it has a square face throughout its whole length, it is flopped over on the flat side by the hooks. If it is stubborn about falling into position, it is pushed and butted into line. From then on the life of the log is short. It is either squared up on all sides as a timber, or it is rapidly converted into cants.

To describe most effectively the movements of cants after they pass from the head rig, the figures of the old-fashioned square dance serve the purpose best. In the reduction of cants to lumber, it is a continuous succession of forwards and backs, allemandes right and allemandes left, sashays, until finally the lumber goes out of the vast building in two columns, "ladies to the right and gents to the left."

The cants, as they come from the saw, are 4 to 12 inches thick, according to the judgment of the sawyer and the schedules called for. Also, a certain number of squared timbers are cut from some of the logs. Everything falls on to a long row of rollers, called the live rolls or roll case. This extends straight ahead from the head rig across the building and out on to the timber dock, several hundred yards away. But the cants which are to be reduced to lumber of various grades and dimensions begin such an amazing and complicated set of movements that to describe it in detail would require a small volume, and to diagram it would lead to something more complicated than a radio-receiver hook-up.



STARTING THE DANCE OF THE CANTS

As they come off the log, cants are from 4 to 12 inches thick. From then on they go through a series of involved movements until they are finally reduced to lumber of various grades and dimensions. Here is a cant traveling down the roll case to begin the dissecting process.

Before getting hopelessly lost in the maze, a few steps may be taken in the early stages. A cant comes down the roll case head on. To the right of the roll case, and some distance from the head rig, stands a bull edger. All the first cants from the log have rough bark edges, so they must visit the bull edger to have these edges squared up. To accomplish the transfer, a bumper or stopper is heaved up between the rolls at the proper point by a piston working in a compressed-air cylinder on the floor beneath. This stops the cant. Then a series of chains traveling at right angles to the line of rolls is hoisted up between them at one end and lifts the cant off the rolls and moves it laterally to a position in front of the bull edger. These transfer lifts are located in numberless places throughout the mill and are all operated by air cylinders.

At the bull edger, the end of the cant falls on a lower roller in front of the edging saws, and instantly a heavy roller, that has been poised above by compressed air, is released and drops down. Squeezed between the two rollers, the cant is drawn through between the edger saws and is squared up. The strips cut from the edges fall on to a series of chains traveling at right angles and are carried sidewise under a series of circular saws, called slashers. These are all on one shaft and mounted about 4 feet apart. They reduce the apparently waste material into 4-foot lengths from which laths will eventually be made.

The forward movement of the squared-up cant continues on another line of rolls beyond the bull edger and parallel with the main roll case. If it is needed for a timber, up come another stopper and another set of transfer chains and send it to the left and on to the main roll case. But perhaps it is a nice piece that is needed for 2x6's. Chains once more transfer it to the right, and over it goes in front of a gang saw which contains 37 vertical saw blades. Here the cant is again pinched between rollers and thrust against the saws, set 2 inches apart, coming out on the other side cut in the desired dimensions except as to length. Another move by chains to the left, and the pieces are brought in front of a row of trimmer saws. There are 24 of them, and each saw is held up above the table by the piston of an air cylinder.

An operator in a little cabin above the line of timbers scans them carefully as they approach the trimmer saws. Before him is a row of tiny levers, each connected by a wire to the release of a cylinder holding up one of the saws. He continually plays upon these levers, dropping saws here and there along the line—one, two, or a number at a time—reducing the timbers into various standard lengths; removing knotty or shady portions here and there; in the case of certain sticks cutting off only the ends; dividing others into two or three pieces, and so on. The speed with which he works, and the numberless instantaneous decisions he has to make give one brain-fag.

But let us go back to the first cants taken from the sides of a log. Each is flat on one side. The bull edger squares up two other sides, leaving one as nature made it. One end of the cant may be thick and then taper to nothing at the other. Still, there is a lot of good lumber in it. It goes to the right on chains down to the re-saw mill. This machine as you face it has two wheels, hubs towards you. A band saw operates on the wheels so that the upper half, which does the sawing, is horizontal, teeth facing you.

Each cant is drawn on to a table flat side down and the irregular, tapered, bark side up. By an ingeniously arranged air-cylinder hoist, the table is elevated just enough to take off, say, a 1-inch board. This slice falls on a set of chains and travels up an incline. But the main piece has to go through again and again. Since it cannot go backward through the saw, it is sent around to the front in a series of rights and lefts on chains, until the whole is reduced to boards. As the slices from it reach the top of the incline, a man stationed there directs the shorter and poorer ones to one set of chains and the better ones to another. These take separate routes, the sizable pieces going to a set of trimmer saws to make board lengths and the others to slashers to be cut into waste or lath material.

The foregoing is only the fringe of the

THE DOCKS

Adjacent to the mill are 2,000 feet of docks. To them the various Long-Bell products are brought by overhead carriers, tractors, or by rail, and are loaded into ships which carry them to all parts of the world.

operations that go on in that mill. At various places, trimming saws are set up for reducing the lengths. Inch boards, 2-inch planks, 2x4's, and so on, are coming off at different points beyond the bull edger. They proceed forward, and to the right or left, sometimes over and sometimes under other lines. The farther it goes, the more complicated the system appears to be. From the other head rig, similar lines are approaching to add to the maze. At various points men are stationed who know lumber and their business. They direct the streams here and there—selecting, separating. But in the end, all the lumber that does not go to waste or lath stock collects in two lines and thus leaves the mill. One is for green lumber, which is to be shipped as such, and the other leads to the dry kilns where the lumber is prepared for the adjoining manufacturing plant where it is made up into finished products.

Service conditions under which the head-rig band saws operate may be gathered from the facts that the total stress or pull upon a saw is approximately 24,000 pounds, and that it travels at the rate of 2 miles per minute, or something like 100,000 miles during its lifetime. It is not surprising that the saws must be changed three times a day for filing and swedging. Filing is the word, although files have not been used for many years, having been replaced by automatic grinding wheels. Nevertheless, they speak of the saw-filing room and the head-saw filer.

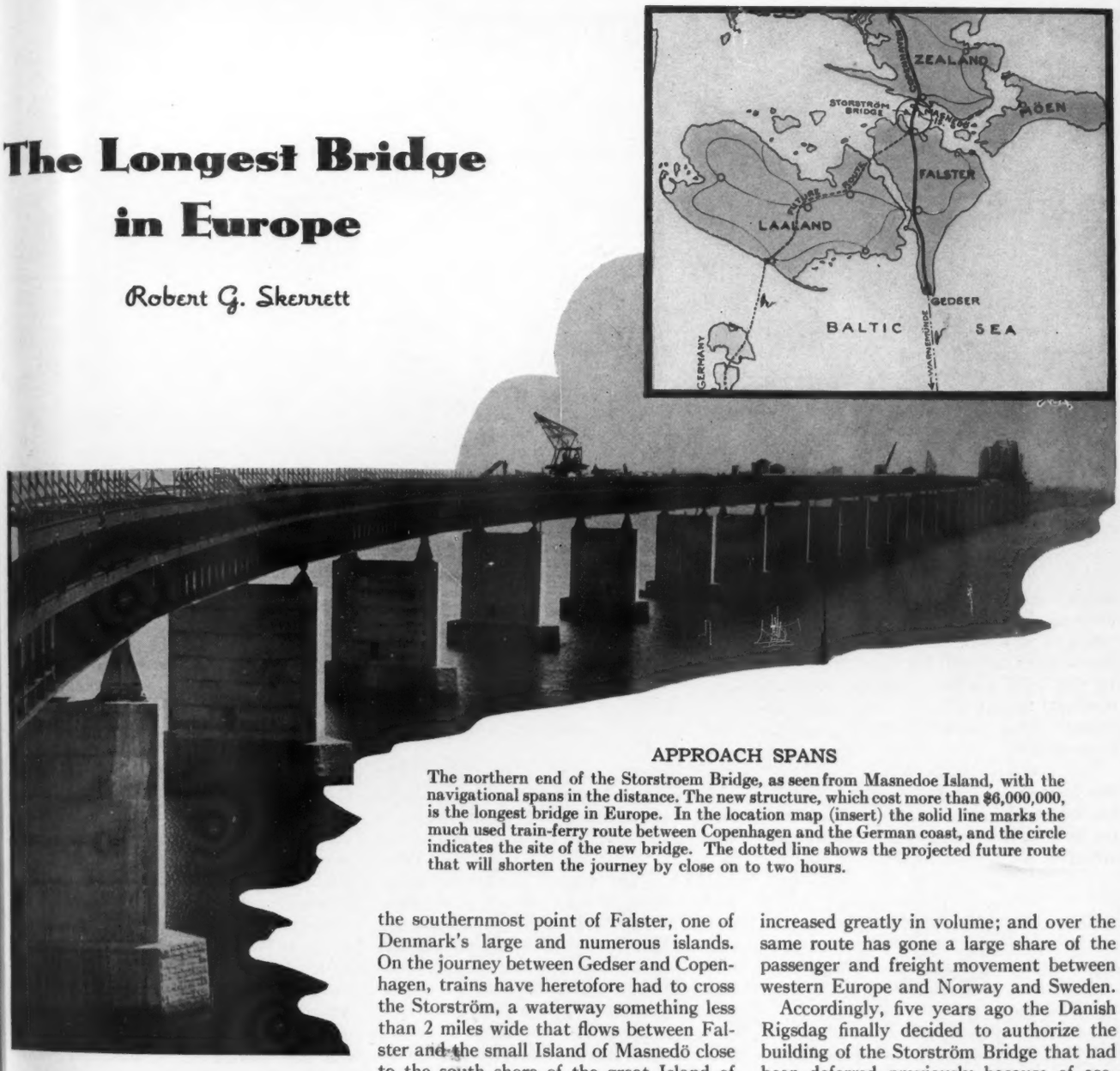
On Head Rig No. 1, saws are changed at 10.30 a.m., 2.30 p.m., and 5 p.m. There is a suppressed tension in the filing room when it is about time for a saw to come up from the head rig immediately below. Men take their places, for the work must be done fast because the head rig with its high-paid sawyer and block setter has to be idle in the interval, and the flow of timbers and cants must be interrupted. At a signal, the saw is pulled from the wheels and raised by an air hoist through an opening to the filing-room level. There, two men are waiting for it and throw it from the lift arms to the floor. Seizing the loop at the forward end, they race with it across the room to a position in front of the filing rig and drop it teeth up. With scarcely a pause, they grab a sharpened saw, race back, give it a hitch on to the hoist, and down it goes. The whole operation has taken perhaps half a minute.

Saws to be sharpened are put on the rig in a horizontal position and made to revolve slowly. As one tooth after another is positioned under the grinding wheel, the latter makes one pass, down and up, and the edge of the tooth is brought to almost razor sharpness. In order that the saw may not bind, the cutting edge of the tooth is wider than the shank. As it wears down, it must be repeatedly swedged. This is accomplished by an automatic compressed-air tool which seizes the two sides of the cutting edge and, by the application of pressure, actually flows the metal to the desired proportions. This is also a step by step operation as the saw slowly revolves.

Products of the Long-Bell Lumber Company are distributed far and wide in the United States and in many foreign countries. The plant described is not its only one, there being others in Oregon, California, and in the South. The executive headquarters are in Kansas City, Mo., where the president of the firm, M. B. Nelson, is located. Vice president L. L. Chipman is in charge of the Longview plant, with C. A. Huffman, construction engineer, and H. M. Cone, chief engineer, on his engineering staff.

The Longest Bridge in Europe

Robert G. Skerrett



APPROACH SPANS

The northern end of the Storstroem Bridge, as seen from Masnedoe Island, with the navigational spans in the distance. The new structure, which cost more than $6,000,000, is the longest bridge in Europe. In the location map (insert) the solid line marks the much used train-ferry route between Copenhagen and the German coast, and the circle indicates the site of the new bridge. The dotted line shows the projected future route that will shorten the journey by close on to two hours.

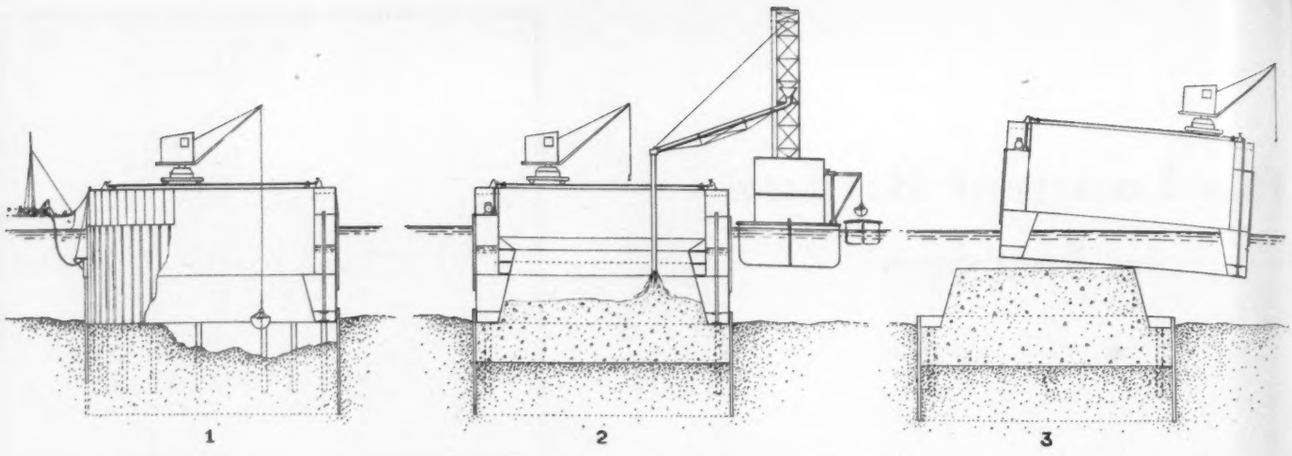
DENMARK has recently put in service the Storström Bridge, a splendid structure built to speed railway travel between Copenhagen, her capital, and the principal cities of the countries that lie to the south in western Europe. Its completion marks one more important step forward in a program of Danish bridge building which has aroused interest the world over in engineering circles. The structures are all designed to save time in transit and to effect substantial operating economies, and, incidentally, to add to the convenience of the traveling public and to give still better service to the shippers of commodities.

The Storström Bridge is on a combined rail-and-water route between Copenhagen and the Baltic Coast of Germany lying southward. The route was instituted 34 years ago when a line of car-carrying steamers was placed on the run between Warnemünde, Germany, and Gedser at the southernmost point of Falster, one of Denmark's large and numerous islands. On the journey between Gedser and Copenhagen, trains have heretofore had to cross the Storström, a waterway something less than 2 miles wide that flows between Falster and the small Island of Masnedö close to the south shore of the great Island of Zealand on which Copenhagen is located. Ever since 1884 trains have been ferried between Masnedö and Falster; but the service has been subject to delays caused by storms, thick weather, and, occasionally, floating ice. At the best, time has been lost in having to divide the trains and to move them on and off the ferries. The Storström Bridge obviates this interruption, and thus considerably shortens the trip between Gedser and Copenhagen. The narrow inlet between Zealand and Masnedö has been spanned by a low bridge ever since the ferry was established.

The steamer run across the Baltic between Gedser and Warnemünde is 30-odd miles long and takes a little more than two hours. Since it was started in 1903 the rail-and-water service has been the most popular one between Copenhagen and the capitals and commercial centers of western Europe. Passenger traffic and freight have increased greatly in volume; and over the same route has gone a large share of the passenger and freight movement between western Europe and Norway and Sweden.

Accordingly, five years ago the Danish Rigsdag finally decided to authorize the building of the Storström Bridge that had been deferred previously because of economic conditions. As a matter of fact, the undertaking would not have been possible then but for an English firm of steel manufacturers and construction engineers that offered to finance and to erect the structure. The proposal was accepted, and actual work on the bridge was started in the spring of 1933. Under the terms of the contract the crossing was to be completed before the close of 1937. However, operations have progressed so well that the Danish State Railways began to use the span early in December of the year gone. This achievement can be more correctly evaluated when it is realized that the Storström Bridge is the longest one in Europe today. The project has cost Denmark about $6,120,000.

The diesel-motored "lightning trains" now traveling across the Storström Bridge were built especially for that service and can maintain a speed of 75 miles an hour on long runs. Each is streamlined, is made

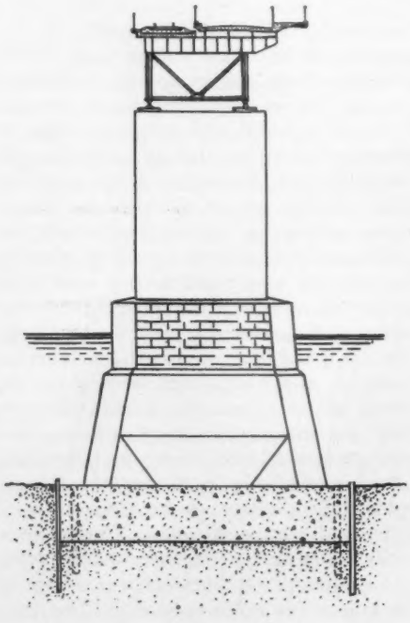


STEPS IN BUILDING PIER FOUNDATION

No. 1—A caisson has been sunk and is resting on sustaining piles. Steel sheet piling of the surrounding cofferdam is being driven with a hammer that is operated with compressed air furnished from a floating compressor plant. Meanwhile, a grab bucket is excavating the inclosed area for the foundation slab of the pier. No. 2—The caisson has been unwatered and concrete for the pier base is being placed. No. 3—The subaqueous pier base has been completed and the caisson, from which sufficient water ballast has been discharged with compressed air, is being floated clear for removal to another pier site.

up of four coaches constructed of duralumin, has an electric kitchen, and is otherwise ultramodern. These 4-coach trains can accommodate 235 passengers each; and they will no doubt be much appreciated during the summer period of heavy tourist travel. In short, the Danish State Railways are equipped to take full advantage of the unhampered run which the new structure has made possible.

The new bridge has a length of 10,532 feet between the terminal abutments and is carried on 51 piers—49 of which rise from the bed of the stream. The steel superstructure is composed of three spans of the stiffened, tied-arch type that are high enough above the navigable channel to permit the passage of large vessels, and of 45 side or approach spans of a cantilever-girder type—the alternate spans being either a suspended span or an anchor arm, according to the location. The central span is 450 feet long, each side span 340 feet, and the approach spans are 190 and 204 feet in length.



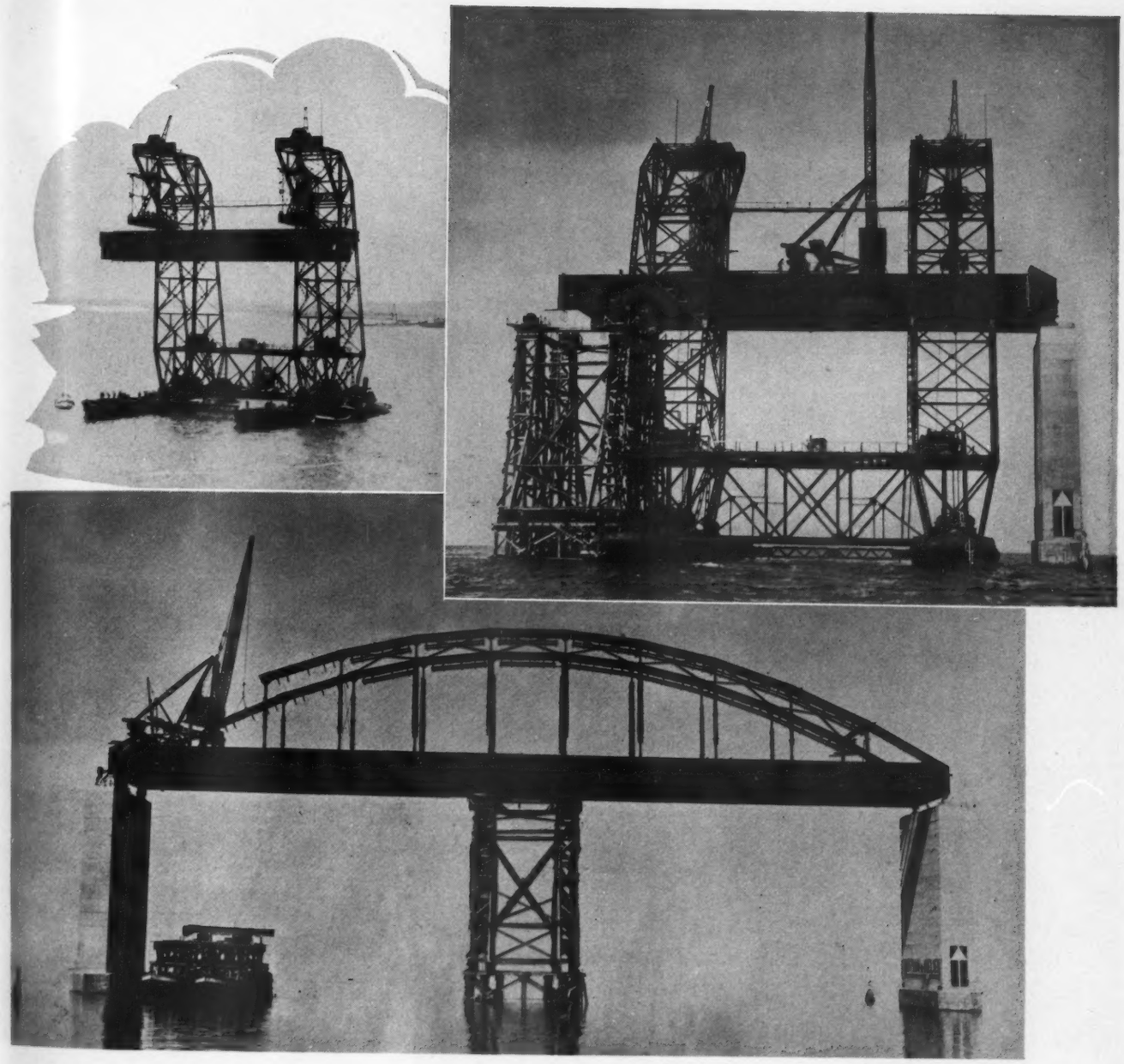
LONGITUDINAL SECTION

Showing the bridge at one of the approach piers. The steel superstructure carries a single railroad track, a 2-lane roadway, and a wide sidewalk for pedestrians and bicyclists.

The fundamental steel structure of both the navigational and the approach spans consists of two parallel plate girders 13.12 feet deep and set 40 feet apart in the case of the navigational spans and 24 feet apart in the approach spans. These longitudinal girders are braced by an extensive system of transverse, horizontal, and diagonal stiffeners and carry transverse floor beams 4 feet deep. The concrete base or floor slabs for the railroad bed and for the integral foundation of the highway and sidewalk are superposed upon the floor beams. The floor system has a width of slightly more than 49 feet, which affords space for a 21-foot rail bed with a single track, for a vehicular roadway 18.37 feet wide, and a walkway 9.84 feet wide. The relatively broad sidewalk is for the convenience of pedestrians and bicyclists—the latter being found in large numbers everywhere in Denmark. The bridge crosses the Storström at an elevation that attains its maximum height at the central span, where there is a clearance of 85 feet for shipping. Traffic there is continuous, and averages 15,000 vessels annually.

The depth of the water along the line of the bridge averages 26.5 feet, but reaches a maximum of 46 feet in the channelway. While the bottom near the shores is covered with a blanket of mud, the basic material of glacial clay is exposed where the water is 20 feet and deeper as the thread of the stream is approached. That clay is generally compacted and capable of sustaining heavy loads resting upon a base area of suitable dimensions. The underlying ledge rock, which is limestone, is at depths varying from 65 to 130 feet. The engineers therefore designed all the piers with footings of ample expanse so as to obtain the required support when the clay was penetrated to a depth not exceeding 10 feet, except at a few points where penetration was as much as 15 feet. Tidal currents have a normal velocity of 7 feet a second—that is, 4.77 miles an hour. The usual rise and fall of the tide is less than 15 inches; but under the drive of strong winds the tidal range may be as much as 3 feet. During severe winters, the Storström is filled at times with heavy floating ice; and this possibility induced the engineers to adopt unusual construction methods for certain of the substructure work. These, together with the associate facilities that were developed, were decidedly ingenious, and served not only to effect substantial economies but also to save much time in building the subaqueous foundations for the piers.

The contractor for the substructures was confronted with the problem of rearing four channel piers of major dimensions and 47 other offshore piers of smaller dimensions and of substantially identical design. Where the work was of a repetitive nature, he recognized that it would be to his advantage to employ caissons and forms that could be used again and again. Mobility was essential; and as the foundation of each pier was a solid unit from the underside of its footing to a point 10 feet below the surface of the water, a caisson had to be devised that could be sunk to the bottom of the stream; that would function there as an enveloping form for the concrete; and that could be refloated so as to permit it being stripped from the pier base and towed elsewhere for a similar service. In addition, it had to be large and self-contained. The contractor, Messrs. Christiani & Nielsen, Danish civil engineers and contractors,



PLACING BRIDGE SPANS

A special floating crane transported the huge span members from their shore assembly base, one by one, and placed each in a single operation over the opening between two adjacent piers. These pictures show successive steps in the erection of the steelwork for one of the navigation spans with the aid of timber falsework at the central point.

proved themselves equal to the task and provided facilities that met all the requirements.

The re-usable caisson employed for the work was an elliptical, double-walled steel structure the interwall space of which was subdivided into a series of ballast tanks that could be filled with water or drained to sink or to refloat the structure, as occasion demanded. Water for destroying buoyancy was admitted through suitable bottom valves; and buoyancy was restored by emptying the ballast tanks with air under pressure. Each caisson was equipped with operating apparatus and carried, mounted on its top transverse and longitudinal stiffening structure, a traveling derrick of ample capacity to handle dredging buckets and any other weighty equipment that was needed to facilitate operations. It served the twofold purpose of a cofferdam—that is, it could be unwatered to permit foundation excavating and the placing in the dry of concrete. In the latter case its internal conformation was such as to correspond to the shape of the pier base to be poured within it. The majority of the bases were constructed with caissons of this description; and because of them it was possible to rear a pier from the base slab up to a level 10 feet above the water well within 30 days. Before a caisson was towed to a pier site, its exterior wall was hung with steel sheet piles in sufficient number to constitute a cofferdam when driven into the water bed and overlapping the bottom of the caisson a few feet.

Prior to submerging a caisson where the stream bed was a firm clay, a succession of piles was driven around the area of the pier base in the form of an ellipse slightly smaller than the dimensions of the caisson. After the latter had been sunk on top of that foundation, the steel sheet piles suspended on the outside of the caisson were forced deep into the water bed with pneumatic pile drivers supplied with air from a floating compressor plant. When in position, the space between the uppermost ends of the sheet piling and the outer caisson wall was sealed with a tar-soaked fiber packing

NAVIGATION SPANS

The central span is 450 feet long and the side spans are each 340 feet long. The maximum vertical clearance for ships is 85 feet. This waterway is a busy one, and is used by about 15,000 vessels annually.

which was inserted by divers. That grommet was further compacted and made watertight when hydrostatic pressure was exerted upon it the instant the caisson was unwatered. When that was done, the dredging of the area for the base slab of the pier was started.

With the excavation completed, the next step in the procedure was the pouring of the massive 10-foot concrete slab in which were embedded the piles on which the caisson was set. The remainder of the base was also placed in the dry, but not until the inward-sloping interior walls of the caisson had been covered with corrugated cardboard to prevent bonding with the concrete—thus making it easier to release and to strip the caisson when the concrete was set. Jacks, acting against the cofferdam piles, first broke the caisson free from the pier base; and as soon as sufficient water ballast was discharged, the caisson floated up and clear of the submerged top of that base. It was then towed to the next pier site for re-use.

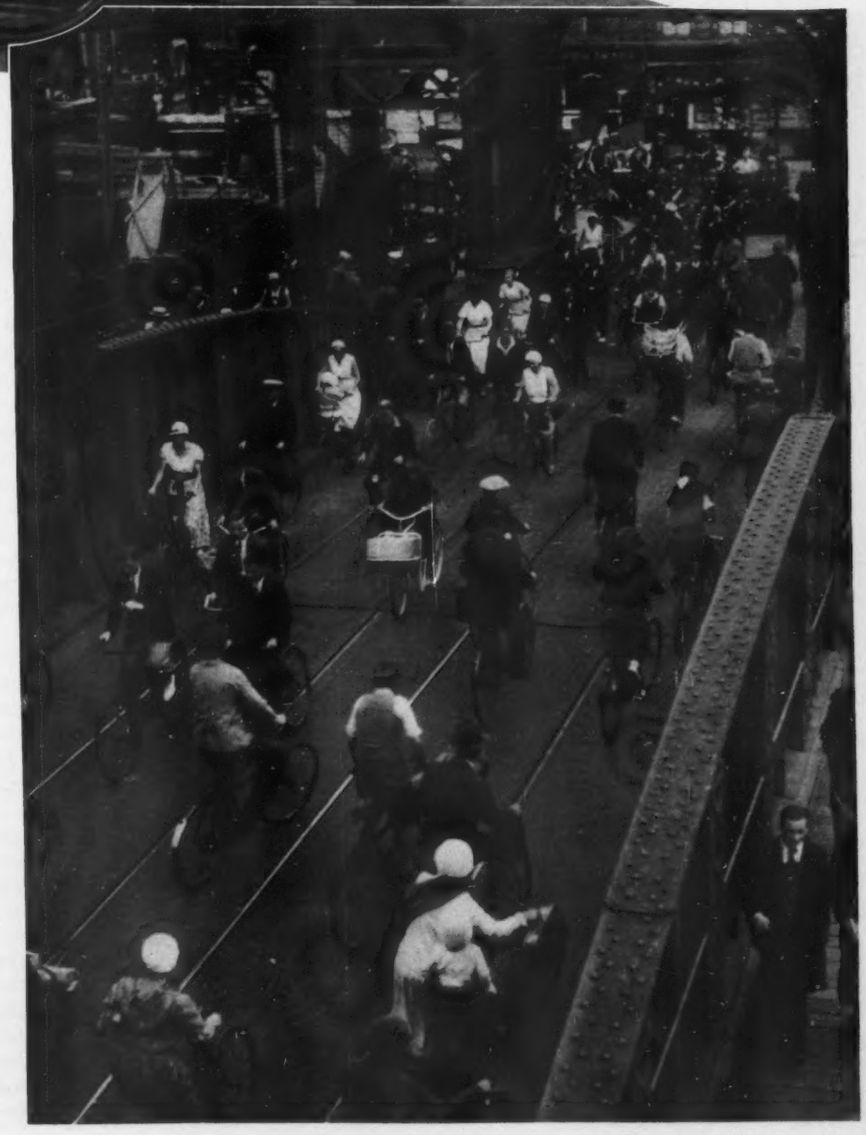
The precise nature of the water bed underlying every pier was predetermined with the aid of an ingenious hydraulic sampler that made it possible to recover at every point of exploratory boring an undisturbed cylinder of the bottom material. Each sample was carefully tested by means of a cone penetrometer, which measured the sustaining power of the clay or any mixture of sand and clay encountered. Wherever sand underlay the firm clay, a modified procedure was followed in establishing the pier base in the water bed. In that case, a steel caisson large enough to envelop a steel-sheet-piling cofferdam was employed, and the piles for the cofferdam were driven from within the caisson and as close against its lower interior face as practicable. Foundation excavating was done in the wet, and the concrete for the base slab and part of the structure immediately above it was poured high enough to form a bottom seal that would permit the cofferdam to be unwatered so that the remainder of the base could be built in the dry up to the prescribed elevation of −10 feet. With that work finished, the caisson was released, floated, and moved away for service elsewhere.

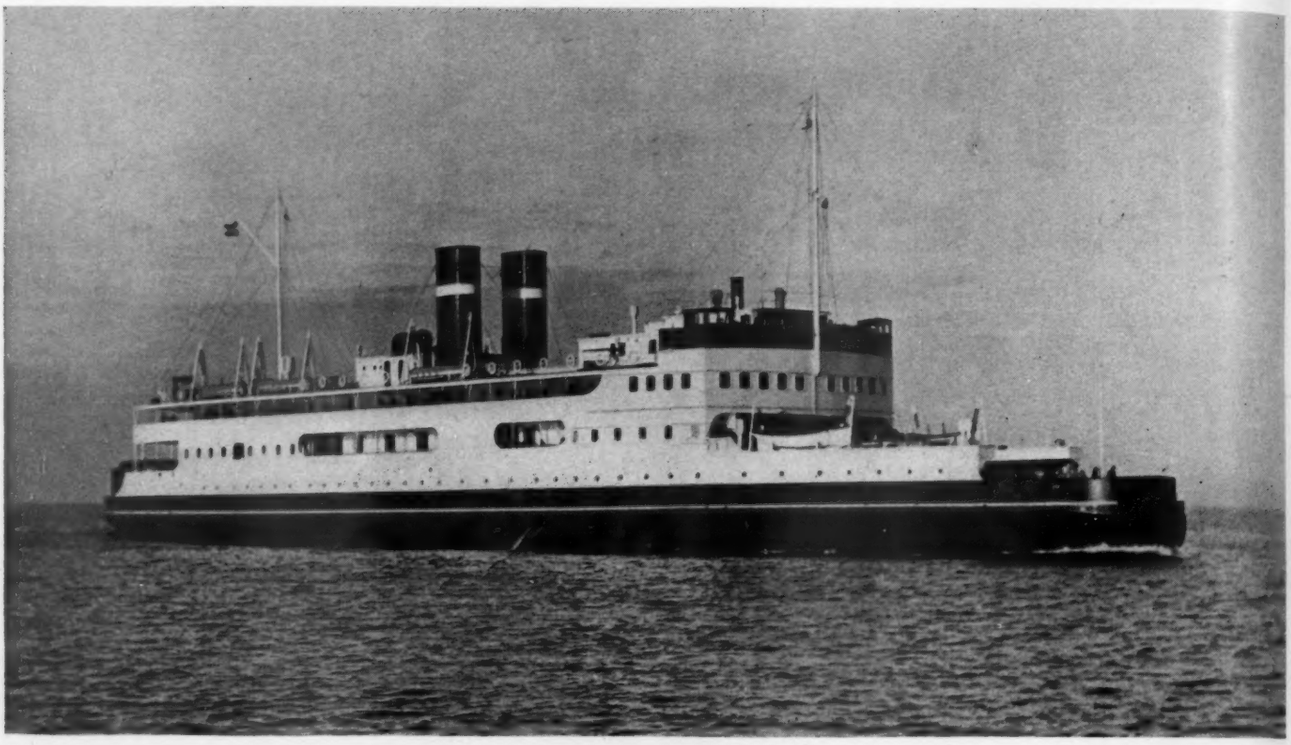
THE LAND OF CYCLES

Nearly everybody in Denmark rides a bicycle. Hence the new bridge carries a walkway about 10 feet wide for the use of pedalers and pedestrians.

Concreting underwater was done with tremies by the so-called "contractor" method, which has proved successful abroad. It consists of pouring the concrete in comparatively small areas confined within unit cells—the flexible conduit through which the material is delivered having its discharge at the bottom and center of a cell. After the initial layer of concrete is thus placed—the hose remaining undisturbed—the succeeding concrete is pumped into the cell below this first layer, which rises like a piston as the column beneath is extended upward. The top layer acts as a protecting coat that is finally removed to afford a good bonding surface for the concluding lifts, which are poured in the dry. In this manner, underwater concreting can be done quickly.

No matter which of the two types of caissons was used, all the pier bases were topped at 10 feet below the surface of the water. The succeeding 20 feet, which brought them well above the stream, was erected in the following unusual manner. Each of those sections was a hollow, buoyant, reinforced-concrete structure or caisson which was built on shore, launched when ready, and transported to the pier site between two barges. They were faced with cut granite, embedded in the concrete, to give them greater protection against ice, wave action, and the possible impact of a colliding vessel. Each one of these caissons, when spotted exactly over its base, was weighted with enough water to make it sink and settle firmly into place—the top of the under structure having been given a thick coating of an asphaltic mixture to as-





TRAIN FERRY

Large, steam-driven boats of this type transport international trains, automobiles, and passengers between Denmark and Germany, making the 30-mile crossing of the Baltic Sea in a little more than two hours.

sure a watertight seal at the peripheral contact edges of the caisson. Afterward, when that bond permitted, the caisson was unwatered and filled with concrete which, incidentally, rigidly tied it to the supporting foundation structure. The surmounting pier shaft was then poured well clear of the tideway and in a collapsible form that was used repeatedly.

All told, more than 40 piers had their bases constructed by one or the other of the two methods described, while the four much larger piers and the two abutment piers were reared within cofferdams of steel sheet piling. A similar procedure was followed in the case of a few piers that are located in shallow water. At the abutments, as well as at some of the other piers, the tops of the steel piles were cut off down to the water level and the remainder left undisturbed as a defense against erosion. Riprap was banked on the water bed around the bases of all piers as a further check against the scouring action of the currents.

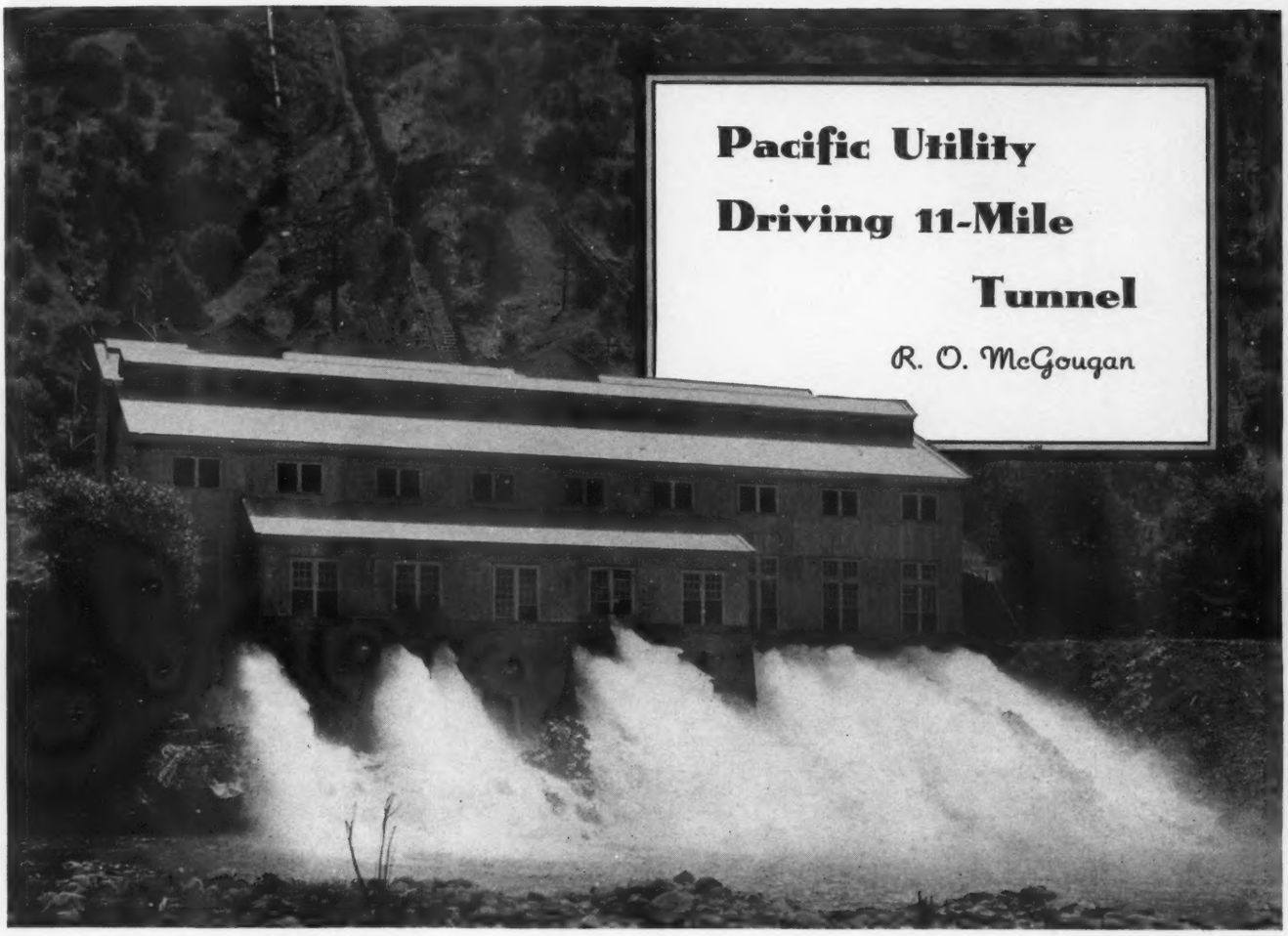
The steelwork of the bridge superstructure was manufactured, fabricated, and erected by Messrs. Dorman, Long & Company, Ltd., of Middlesbrough, England, who also financed the entire project. Most of the steel is alloyed with chromium and manganese, which assures a high degree of strength. The basic span members, that were previously described, were prefabricated integrally and placed in a single operation over the opening between each pair of adjacent piers. To do this work, the contractor made use of a great 500-ton crane, having two towers, that was carried on two barges held apart by a suitable arrangement of cross braces. The crane, equipped with two powerful hoists, was able to lift the heaviest of the structural units, to transport it from the shore base, and to raise it to the necessary height before lowering it on to the piers at the exact points desired. The practices followed by the English company in the diversified operations enabled it to complete the job a whole year sooner than was required by the contract.

The terminal approach spans near each shore connect with long ramps that lead up to the abutments, which rise approximately 60 feet above the water level. These ramps are earthen embankments that have a maximum gradient of 6.67 per cent. The ramp on Masnedö Island is a long, sweeping compound curve that links the Storström Bridge with a new bridge across Masnedsund—the narrow waterway between Masnedö and Zealand. This structure is part of the general improvement, and was built simultaneously with the Storström Bridge. It consists of five spans having a combined length of substantially 607 feet. The central span is movable and can be swung horizontally to provide a passage for the smaller craft that use that waterway. All its piers were constructed within cofferdams of steel sheet piling; but at some points, where sand was encountered, it was necessary to seal the cofferdams with a deep slab of concrete, placed by the contractor method, before they could be unwatered. Minor but essential auxiliary works are represented by seven small bridges and viaducts, a tunnel 230 feet long, and a highway more than 6 miles long. The Storström Bridge, alone, called for the use of 20,000 tons of steel and 143,875 cubic yards of concrete, while the approach ramps entailed the placing of 2,615,900 cubic yards of earth—figures that help us to grasp the fact that the crossing is one of major proportions.

Curious-minded people may wonder why so much money has been spent on the Storström Bridge when there still remains the long train-ferry run between Gedser and Warnemünde. As a matter of fact, that structure will make it possible to carry out another phase of the project, which involves the building of one comparatively short bridge that will open up on Danish territory a new route extending to the southwest shore of the large Island of Laaland. There a ferry run, a little more than a third as long as the present one, will form a link with Germany and thus proportionately reduce the Baltic crossing. Then Lübeck, Germany, will become the distributing point for through traffic between Denmark and the cities of western Europe. Once more we see that the urge to save time, where economically practicable, is by no means peculiar to our country, but is evidenced among all progressive nations the world over. The modern engineer and the mechanical aids which are now at his disposal make it possible to satisfy this demand.

Pacific Utility Driving 11-Mile Tunnel

R. O. McGougan



STANISLAUS POWER PLANT

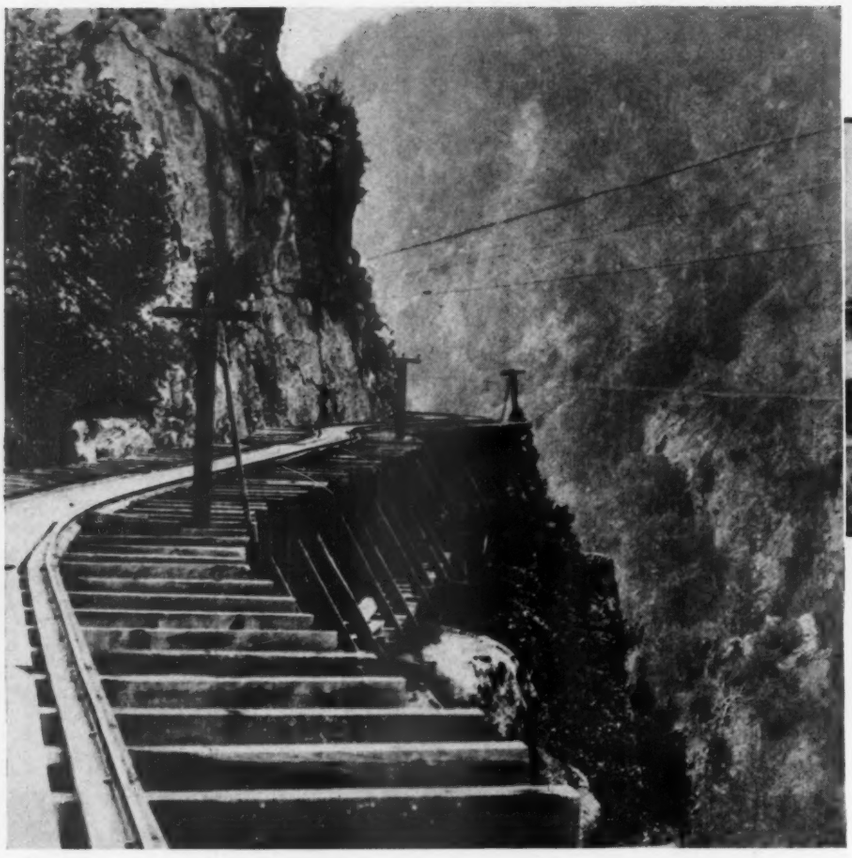
The tunnel will carry water from the higher reaches of the Stanislaus River to operate this station. The plant has a generating capacity of slightly more than 45,000 hp., and is one of many in the Pacific Gas & Electric Company system.

AN ELEVEN-MILE tunnel through solid rock is being constructed in Tuolumne County, California, by the Pacific Gas & Electric Company to supply operating water for the Stanislaus hydroelectric power house. The tunnel will replace the 17-mile-long Stanislaus flume, a winding wooden structure which, since 1908, has carried water from storage reservoirs on the south and middle forks of the Stanislaus River to that generating station.

The scene of the operations is in the Sierra Nevada Range, some 125 miles east of San Francisco. It is in the southerly part of the Mother Lode District, the fabulously rich mining section that figured prominently in the excitement of 1849 and that made California one of the Union's leading gold-producing states. The region was once the home of Mark Twain and of Bret Harte, and is the locale of some of their most popular stories. It was the scene of many daring stagecoach holdups or raids by Joaquin Murietta, Black Hart, and other notorious desperadoes of the hectic era of widespread lawlessness that kept "Judge Lynch" on the jump. Within its confines is the historic community of Columbia. The latter is now a "ghost" town maintained as a state park; but back in the fifties and sixties, before its gold petered out, it was a bustling and boisterous mining camp of several thousand population and at one time a strong rival of Sacramento when the state capital was being selected. Nearby is the pioneer mining settlement of Angles Camp, which has attracted considerable attention in recent years with its annual frog-jumping contests.

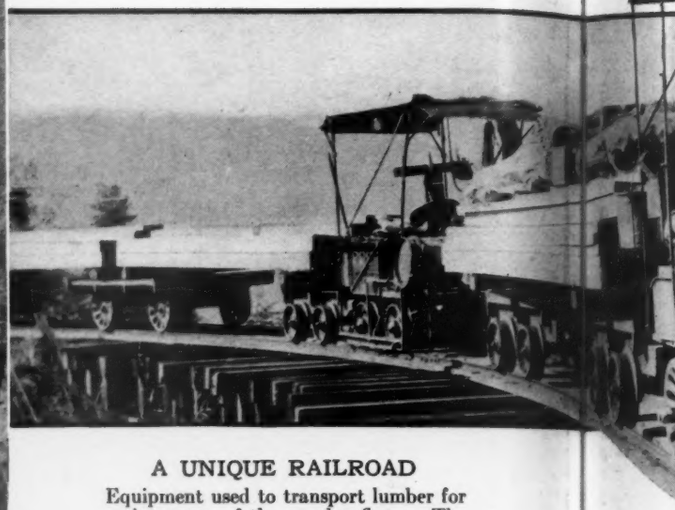
The estimated cost of the tunnel is $1,810,000, and it is expected to be completed in four years. The company will carry on the work under the direction of O. W. Peterson, engineer of general construction, and will employ 125 men, most of them former employees of the concern. The Federal Power Commission has approved the plans and specifications for the tunnel and issued a permit for its construction. This was required because a part of the aqueduct route traverses Government land. A modern camp for housing the workers has been erected, the necessary plant and equipment assembled, and actual driving of the bore is now getting underway. Materials and supplies are taken in over a narrow-gauge railroad that was originally built on top of the flume for the purpose of supplying lumber for repairs.

It is felt that the substitution of a tunnel for the flume will lead to substantial economies, even though the first cost will be considerable. The saving will come about through the elimination of the large annual expenditure for maintenance of the wooden structure, which is 9 feet wide and 6 feet deep and is supported on a timber trestle built on ledges on rugged mountain slopes. An average of 1,500,000 feet of lumber and timber has been required annually for the past 25 years or so to make the necessary replacements and repairs, and a crew of 45 men has been continually employed. The carrying charges on the tunnel investment will be considerably less than the amount that has been spent in keeping the conduit in serviceable condition. Placing the waterway underground will also put an end to the interruptions in the operation of the Stanislaus power plant that have resulted from breaks in the flume. Rock slides have frequently swept away sections of the conduit, sometimes as much as several hundred feet at one point. In addition to crippling the generating station, these avalanches have menaced the safety of the workmen.



SECTION OF FLUME

Since 1908, water to turn the turbines of the Stanislaus power plant has been carried by a 17-mile, open, timber conduit, of which a section is illustrated. It will be replaced by the 11-mile tunnel now being driven.



A UNIQUE RAILROAD

Equipment used to transport lumber for maintenance of the wooden flume. The tracks, laid on top of the conduit, are being employed to haul equipment and materials required for driving the tunnel.

Stanislaus Tunnel will be built in three units, one at a time; and as soon as each is finished it will be put in service and the corresponding flume section abandoned. The first stretch to be driven will be at the end nearest the power plant and will be 3¼ miles long. Its cost is estimated at $560,000. It will replace more than 7 miles of flume, and is scheduled to be completed by the end of 1937. Work has been started at a picturesque spot called Gridstone Gulch, about midway of the section. An adit is being driven into the hillside to intersect the tunnel line, after which drilling will be carried on in both directions. A similar procedure will be followed in driving the second and third sections.

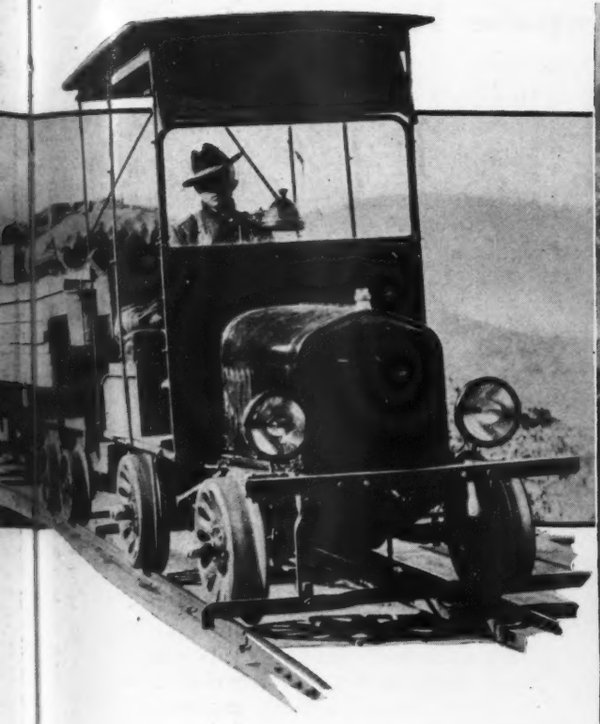
So far as it is possible, all details of the construction are being planned beforehand, to the end that the work may be thoroughly organized for the greatest efficiency. In consequence, it is believed that new time records may be established for a rock tunnel of its size, barring unforeseen difficulties. Everything is being geared for top-speed operations. Work will be carried on 24 hours a day with three 8-hour shifts at each heading, and the most modern mechanical equipment available will be employed. The engineers in charge have set a tentative schedule of 60 feet of tunnel a day —30 feet per heading—whereas 20 feet a day, under similar conditions, was considered good progress ten or twelve years ago.

As a means of speeding up drilling there will be a drill carriage or "Jumbo" at each heading. Each carriage will be provided with four drifter-type rock drills using 1¼-inch, hollow, round drill steel and will be mounted on flanged steel wheels running on 30-inch-gauge track built of 40-pound rails. Operating on the same track and at each heading will be a 12-ton mucking machine, consisting of a shovel capable of loading 45 cubic yards of rock per minute on to a 22-inch-wide conveyor belt that will carry it backward and drop it into dump cars. These were designed for the job by engineers of the Pacific Gas & Electric Company and of the Mutual Engineering Company of South San Francisco. They have steel sides, are 12 feet long and 3½ feet wide, are mounted on two 4-wheel trucks, and have a capacity of 5 cubic yards each. Five 8-ton, battery-type electric locomotives, that will run an entire day without recharging, will do the hauling. To facilitate the switching of empty and loaded cars, short spur tracks will be laid at 500-foot intervals—the tunnel to be widened slightly over short stretches to accommodate them.

Especial attention is being given to ventilation—to supplying an adequate amount of fresh air at the headings and throughout the workings to keep them clear of dust and powder gases and to minimize the hazard of silicosis. Details of the system are being worked out by Pacific Gas & Electric Company construction engineers and S. C. Dickenson, the company's safety engineer, in conjunction with representatives of the California Industrial Accident Commission. To supplement their ideas, suggestions will be sought from several physicians, including some who have had long experience in combating the effects of dust in the mines of the Mother Lode area. To increase efficiency and to create more comfortable as well as safer working conditions, a carefully planned system of electric illumination will be installed. All construction equipment will be finished with aluminum paint to help diffuse light.

In order to take full advantage of the mechanical aids, the operations will be systematically organized to secure the greatest speed consistent with safety and efficiency. After a round of approximately 25 holes has been drilled, each from 8 to 10 feet deep, the carriage will be moved back and the holes loaded with dynamite. Approximately 2,500 pounds of explosives will be used every 24 hours, and all firing will be done with electric detonators. Following blasting, a mucking machine will be shunted in to load the broken material into trains that will haul it out through the tunnel and adit for disposal. Then the same sequence of operations will start all over again. With each cycle the tunnel will be advanced 8 to 10 feet. The amount of excavating involved is estimated at 225,000 cubic yards.

In accordance with a long-standing company policy, the camp for the workmen



will be a model of comfort and convenience. All structures will be of the unit-built type, fabricated from prepared panels. They will be insulated against both heat and cold with aluminum foil.

As might be expected in the case of operations conducted by a concern whose business it is to produce, distribute, and sell electricity, that medium of power will play an important part in all the construction activities. Current, which reaches the work through a line now used in the maintenance of the wooden flume, will be applied in many ways. In the camp it will light and heat the buildings, do the cooking, operate labor-saving kitchen devices, and heat water for shower baths. On the job, it will operate air compressors, mucking machines, serve the lighting and ventilating systems, and charge the batteries for the locomotives.

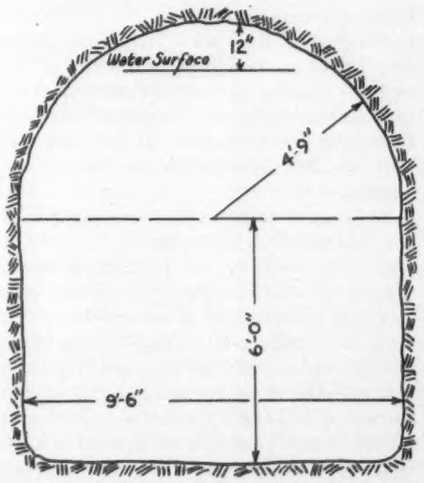
The tunnel will be driven through granite, which exploratory tests indicate is free enough from fractures to require no support during construction. It will also be unnecessary to line it with concrete prior to placing it in service. In cross section it will be in the form of an inverted U, with a maximum width of 9½ feet and a maximum height of 10¾ feet. Its carrying capacity will be 350 feet of water per second.

The Stanislaus power house has a capacity of slightly more than 45,000 hp. It is one of 59 generating stations of the Pacific Gas & Electric Company's extensive interconnected system. These stations have an aggregate generating capacity of 1,671,037 hp., and their output is transmitted and distributed over 36,020 miles of lines. Through these facilities, the company serves an area of 89,000 square miles in 46 of the 58 counties in California.

AFTER AN AVALANCHE

Maintenance expense of the flume has normally been large, and at times the structure has been put out of service by rock slides. The picture gives a good idea of the difficulties encountered in a section swept away by an avalanche.

O. W. Peterson, construction engineer in charge of the operations, brings a wide and long experience to his duties. He was graduated from the University of California in 1904. His first important work was on the Colorado River closing project—a task that consisted of shutting off a course taken by the stream many years ago and diverting it into its original channel. From 1909 to 1913 he was a divisional engineering superintendent on the Los Angeles Aqueduct, after which he was selected by the Pacific Gas & Electric Company to oversee the building of the Drum hydro-electric system on the Bear River in Placer County, California. Following that, he became construction engineer on the Modesto Irrigation District's development, which serves an extensive tract of farming land in Stanislaus County. During 1918 and 1919 he installed a hydro-electric system in Korea for an American mining company. Upon returning to California, he helped the Great Western Power Company build a 2-mile tunnel from Lake Almanor, the largest artificial lake in the United States, to Butt Valley, which serves as a reservoir for the Caribou power house. About fifteen years ago Mr. Peterson returned to the staff of the Pacific Gas & Electric Company and has since handled many important construction assignments, including the Pit River power project in Shasta County, the Lake Spaulding hydro-electric development in Placer County, the Mokelumne River project in Amador and Calaveras counties, and several others.



CROSS SECTION

This simple shape was decided upon after several others had been considered. Rock conditions are such that it will not be necessary to support the tunnel during construction nor to line it for service.

"Down North" on the McKenzie River

SHOOTING THE RAPIDS

Pioneer transportation on the Athabaska River, Alberta, Canada. The picture was taken in 1915, and shows part of a Dominion Government land survey party headed by Fred V. Seibert. In the 50-foot scow, from left to right, are: Johnas Powder, Francis Lepine, Mr. Seibert, and Charlie Saunderson. The first and last named were experienced river pilots. It will be noticed that all hands are alert and that the cargo is tied down.

THE accompanying illustration is of a type of scow that was used extensively until about 25 years ago for navigating the headwaters of the McKenzie River system in Canada and that is still found on some of the shallower streams in Saskatchewan, Alberta, and the North West Territories. It shows the boat passing over the Big Cascade, on the Athabaska River, between Edmonton and Fort McMurray, Alta., and was taken in 1915 when the scow was transporting a Dominion Government base-line survey party, in charge of Fred V. Seibert, from Athabaska Landing northward to one of the base lines below Fort McMurray. Mr. Seibert is now superintendent of the western region of the Department of Natural Resources of the Canadian National Railways, and it is through his courtesy that we are privileged to reproduce the picture.

Such scows were formerly employed by the Hudson's Bay Company for its McKenzie River transport; and from H. G. Reid, manager of the Winnipeg office of that concern, we learn that as many as 80 of them were in service one season. They were built by the company on a wholesale scale, and in 1914 cost approximately $125 apiece without sweeps and oars. Each boat was 50 feet long, 10 feet wide at the bottom, 14 feet wide at the top, and had sides 3½ feet high. They were constructed entirely of sawed timbers of native spruce, and were fastened together with 4-inch wire nails, calked with oakum, and finished with pitch. Each was equipped with a wood pump having wood and leather valves. Sweeps and oars were hewn from trees.

Scows of this sort at one time carried much of the commerce of the North and figured prominently in the early activities of the Hudson's Bay Company and of the Dominion Government's topographical and mineral survey parties. Inspection of a map of Canada will show that Edmonton is situated close to the headwaters of the McKenzie River system that flows northward, and also to those of the Saskatchewan flowing eastward to Lake Winnipeg. It was established as the principal trading post of the Hudson's Bay Company in what is now Alberta and at a time when that concern ruled western Canada and handled most of its trade. Every spring, the furs, leather, and pemmican that had been gathered from a vast territory to the north and west of Edmonton were sent down the Saskatchewan in boats to Lake Winnipeg and thence in canoes to Hudson Bay. At their destination they were exchanged for goods needed in the fur trade, and these were taken back over the same route.

From Edmonton northward to Fort McMurray, a distance of some 300 miles, commerce plied the Athabaska River. This is a rather shallow stream in places; and before reaching Fort McMurray navigation is impeded by a 90-mile stretch of rapids. The scows, being broad and of low draft, were well able to negotiate this sort of waterway. In the summertime, when the river was at high-water stage, they carried from 10 to 12 tons of cargo. In the spring and autumn the load was limited to 5 or 6 tons. Below Fort McMurray, where the Clearwater River empties into the Athabaska, they carried 10 to 12 tons throughout the open season. Today, Edmonton still holds its strategic position as a supply depot for a large expanse of territory and has, accordingly, become an important wholesale and jobbing center. The Northern Alberta Railway connects Edmonton and Waterways, which is within 3 miles of Fort McMurray, and commerce which formerly moved on the Athabaska River now goes by rail.

Fort McMurray and the adjacent territory is renowned for its natural wealth, being located within the tar-sand area with its overlying vast salt beds. It is particularly noted, however, as Canada's largest commercial air base—the Mecca of Canada's famed commercial pilots—from which passengers, mail, and all manner of supplies, particularly mining, are flown to all parts of the North. In what are popularly known as "flying box cars," complete mining plants, consisting of air compressors, mine hoists, rock drills, and accessory equipment, are transported to develop the economically important mineral deposits in the North West Territories. Airways radiating from Fort McMurray have given us many sagas about Canadian flying. Beyond Fort McMurray, however, water still is the chief means of transportation when the ice is out. In the winter season, sleds and airplanes are relied upon. As yet there are no railroads nor through highways in the middle and lower basins of the McKenzie River, though an extensive program of road construction, which has been under discussion for the past few years, now seems on the verge of becoming an accomplished fact.

From Waterways, the Hudson's Bay Company runs a weekly steamship service to Fort Fitzgerald, three days' journey away. There a series of rapids makes the river unnavigable over a 16-mile stretch, and both goods and passengers are taken over what is known as the Smith Portage to Fort Smith. In many cases, entire boat loads are carried over the Portage, the method followed being to haul the craft out of the water on rail-borne trucks much like private yachts are beached for winter storage. From Fort Smith, steam and motor boats operate over an unbroken chain of waterways to Tuktoyaktuk on the coast of the Arctic Ocean. The whole journey requires eighteen days. Side trips also provide connections with points on Great Slave Lake and Great Bear Lake and on the Liard and Peel rivers.

As a result of increased mining activities —notably the production of radium ore at Great Bear Lake, and copper, gold, oil, lead, zinc, and nickel at other inland locations—the transportation of freight over this route has multiplied greatly in recent

years. Where these isolated operations are not on navigable waterways, they are frequently served by a combination of transport facilities. Tourists also are beginning to visit the McKenzie River Basin in greater numbers, and, as a result, accommodations where they can be cared for comfortably are becoming more numerous each season at various way points.

It is difficult to visualize the immensity of the territory tributary to the McKenzie River. It embraces 682,000 square miles, or nearly three times the region drained by the Colorado River. Only the Mississippi exceeds it among the drainage basins of North America. The McKenzie presents an anomaly, in that different parts of its course are known by various names. Its principal sources are the Peace and Athabaska rivers. The latter empties into Lake Athabaska and emerges from it as the Rocher. Below the confluence of the Rocher and the Peace, the stream becomes the Slave River, which debouches into Great Slave Lake. From the latter body to the Arctic Ocean, a distance of 1,000 miles, it is the McKenzie proper.

Mining Industry on Canvas

PENNSYLVANIA'S mineral industries, past and present, have been recorded on canvas in the form of 104 oil paintings constituting an art gallery at the Pennsylvania State College. The collection is said to be the only one of its kind in existence, and has attracted wide attention. It had its first public showing recently at Harrisburg, Pa., where it hung in the State Museum during the legislative session.

The paintings are the work of 64 artists, and were donated to the School of Mineral Industries by individuals, industrial concerns, and the Works Progress Administration of the Federal Government. They have been appraised at more than $25,000.

The collection was assembled through the efforts of Dean Edward Steidle of the School of Mineral Industries. He conceived the idea six years ago as a means of making the people of Pennsylvania "mineral conscious" and as a practical visual aid to education. The subjects portrayed cover a wide range of mineral activities, and include steel mills, oil fields, lime kilns, coke ovens, coal mines, glass works, etc.

Such an art gallery in Pennsylvania is entirely appropriate, as the latter is reputed to be the world's greatest mineral commonwealth in point of value of its products. In 1928 the capital investment in its primary industries amounted to $2,780,000,000, or 41 per cent of the total in productive industries. In 1929 those industries employed 610,000 workers and their products were worth $1,700,000,000. The fact that the state holds second position in the nation in population, wealth, and productive industry, is ascribed chiefly to its mineral resources.

Compressed Air from the Sea

GENERAL AND DETAIL VIEW OF PLANT

NUMEROUS efforts, some of them at least partially successful, have been made in various parts of the world to harness the power of the tides and of the waves. The most conspicuous and largest-scale attempt is, of course, the Passamaquoddy Tidal Power Project at Eastport, Me., the construction of which was stopped after something more than a year of work through the failure of Congress to appropriate additional funds.

The accompanying pictures, which were taken a number of years ago, show a plant at Venice, Calif., that was designed to utilize wave action to compress air. The structure was built a short distance offshore. Underneath it were "motors" or wheels that were turned by the incoming waves. By means of chains and gears, these wheels were made to turn shafts on the operating floor above. Through cranks and connecting rods, these shafts operated pistons that compressed air in horizontal cylinders. The air was discharged into storage tanks. The illustrations give a general view of the plant and a close-up of one of the compression cylinders with the base of a receiver behind it.

We are not in possession of information concerning the pressure obtained and the capacity of the equipment. Neither do we know how long, if at all, the plant was operated, nor what use was made of the compressed air. One report is that it was the intention to utilize it to drive an electrical generator. The pictures are evidence that considerable money was spent on the scheme; and there is perhaps an interesting story of frustrated hopes back of it all. We should be grateful for any additional information that any of our readers may be able to supply on the subject.

with an Engineer

BY GLADYS CRAIG POTTER,
Wife of C. A. Potter, Resident Engineer,
California Division of Highways.

WHEN the tired business man wants to lighten his cares
He goes to a snappy show,
And forgets about work and the market reports
As he sits in the very front row;
While a doctor, they say, on a vacation bound,
Will hie himself off to the hills,
Where he'll fish and he'll hunt to his heart's content,
Forgetting his overdue bills;
And a lawyer may pass his holiday
Inspecting the bathing beauties,
As he lies in the sand at a beach resort
And forgets his judicial duties.

BUT an engineer, let me say right here,
Has a very different code!
With his two weeks pay from the State Highway
He will head for the open road!
So don't envy the life of an engineer's wife,
Ye maidens of high social station,
For here's what you'll get when you go on a trip
With an engineer on his vacation:

YOU'LL start bright and early because, don't you see,
He's not used to sleeping late,
And you'll rush through your breakfast and make up your face,
'Cause an engineer hates to wait.
And then when you're out on the wide white road,
Speeding toward your goal,
You'll come to a stretch where they're shooting oil
And the traffic is under control.
Then you'll sit in the car in the broiling sun
With nothing at all to do,
While your husband "talks shop" with the maintenance man,
And at least three patrols go through!

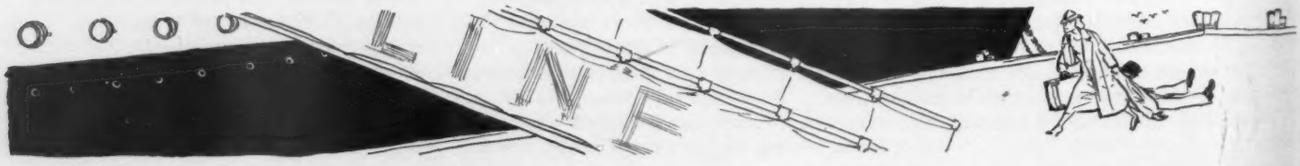
AND when you're at last on your way again
He'll seek your attention to fix
By explaining how smooth is the surface you get
With a D. G. and bitumen mix.
By this time you're thirsty and hot and tired,
So you say, "What about some beer?"
But he passes each stand for the next ten miles
'Cause a new drinking fountain is near,
And he wants to inspect the rubble wall
And the way that the pipes are laid—
So you fill up on water that spills down your dress
And ruins your new pumps of black suede.

ALONG about noon you look for a sign of The Inn
That your friends have all told you about:
"They serve the best luncheon that ever was cooked,
"And, my dear, you should taste their broiled trout!"
But about this same time, as you go up the grade,
You come to a contractor's camp,
And your engineer-husband brakes down with a shout
Of, "There's good old Sammy, the scamp!"
Then he's pounding the back of a gray haired man
As though he were not quite sane,
And saying, "Why Sam, what the hell do you mean,
"Going into the contracting game?"

YOU wait in the car while they talk of old times
When they worked on a location party,
And he finally remembers he's got you along
So he brings over Sam, very hearty,
Who says, "What's the matter with you and your wife
Having lunch in the cook shack with me?"
So you eat a beef stew with hot coffee and pie
While you long for broiled trout and iced tea!
And when finally they put up the layout sheets
And you're once more on your way,
He regales you with stories of S. I. life
For the rest of the long summer day.

NEXT morning you come to a six mile stretch
Which he built back in thirty-two,
And he tells you in detail just how it was done,
From the time that the line was run through
And the first stake punched and the first dirt moved,
And the road built up to grade,
To the hour when the headwalls were polished up
And the last yard of pavement laid!
You try all in vain to point out the beauties
Of village and city and field,
His only reply is to give a long sigh
And say, "This piece should really be sealed."
He admires a deep cut or the arch of a bridge,
He sees nothing else but the highway;

HE can never be urged to turn off and explore
Some interesting-looking old by-way.
So you learn about tangents and angles and curves,
You get quite a good education,
And that's about all that you get when you go
With an engineer on his vacation.
But when you near home, on the last weary mile,
You are struck with a very bright notion!
And "Darling," you say, in your most honeyed way,
"Next year for our trip let's go on a ship!"
(For, thank God, there's no road on the ocean!)



THE HIGHWAY DIESEL

THERE are definite indications that the diesel engine will some day occupy an important place in the automotive field. Wherever gasoline is relatively inexpensive, comparatively little is heard about diesels for highway transport; but in Europe the topic is one of vital interest, and in the past few years the development of highly effective units has noticeably quickened. Writing in a recent issue of *The Engineer*, of London, Harry R. Ricardo, the well-known engine designer, traces that progress and explains how it has come about.

First among the contributing factors he lists the breaking down of the belief that the heavy-oil engine cannot run fast. There never was the slightest foundation for such a belief, Mr. Ricardo states; but, nevertheless, it was a deep-seated conviction. The second influence was the interest taken in the diesel by engineers of long experience in designing and building gasoline engines. They are now making diesels with the same care and thorough methods that they have long applied to the manufacture of gasoline units. Third on the list is the development, by this same group of technicians, of a small precision pump that will accurately both meter and time the injection of minute quantities of liquid fuel over a very wide range of speed.

In designing current high-speed diesels, many time-honored principles were abandoned. In fact, the provisions for injecting fuel oil into the cylinders have reverted to those that were used during the first ten years of diesel development. This is but one manifestation of a revolution, which Mr. Ricardo describes as follows:

"A new school of engineers, with a new mechanical technique and no respect for inherited tradition, took possession of the heavy oil engine and determined to make it dance to an altogether livelier tune, and even to race the petrol engine on the public highways. Its mechanical design they consigned straightway to the waste paper basket, and started afresh with an entirely different conception, in which stiffness of structure and light moving parts formed the central ideal, while economy of material and accuracy of machining, in order both to eliminate hand fitting and insure interchangeability, formed the economic theme."

One of the most surprising things unearthed is that the diesel is capable of running at about twice the speed of the gasoline engine, insofar as combustibility of the fuel is concerned. Experience has likewise shown that the thermal efficiency of diesels is still increasing slightly with greater speed, even at 4,000 rpm. The establishment of these facts opens a wide field for future development that rests on overcoming mechanical difficulties.

Mr. Ricardo states that there are about 6,000,000 bhp. of diesels in service today on the roadways of Europe.

HOMAGE TO AN ENGINEER

HUGE engineering works spring from many brains, and no one individual may claim credit for them. Among the various collaborators, however, the chief designing engineer occupies a place of paramount importance and responsibility. He not only has the final word in determining the broad general features of the structure being built but his decisions usually have a far-reaching effect in shaping the construction methods that shall be followed. In the final analysis, he is answerable for both the safety of the works and the economy with which they are erected.

It is no small honor, therefore, to be the first engineer in the world to have designed a billion dollars worth of structures. The man that holds that rank is John Lucian Savage, chief designing engineer of the U. S. Bureau of Reclamation. In recognition of his achievements, fellow engineers in Colorado presented him with a medal a few weeks ago at a testimonial dinner attended by 300 persons.

Chief among Mr. Savage's creations is Boulder Dam, but that will soon be surpassed in point of magnitude by Grand Coulee Dam. All told, he has designed fourteen dams that have involved an expenditure of $5,000,000 or more each, and 45 lesser ones. Their aggregate cost is $627,470,000. In addition, he has laid out numerous canals and thousands of structures on irrigation projects carried out under the supervision of the Bureau of Reclamation.

Mr. Savage was born in Wisconsin, and attended the state university there. He entered the employ of the Reclamation service in 1903, on the Minidoka project in Idaho. After five years he left it to engage in private engineering practice with one of his associates, the late A. J. Wiley. He spent eight years at that work, but continued his connection with the Bureau of Reclamation in a consulting capacity.

Although his private practice proved lucrative, he longed for the greater field of activity afforded by the Government service, and rejoined the Bureau in 1916, when he was assigned to take charge of the civil-engineering designing work in the office of the chief engineer in the newly established Denver headquarters. He was made chief designing engineer in 1924. In that post he has been responsible for the introduction of numerous applications of fundamental engineering principles. One of these of outstanding importance is the trail-load method of arch-dam analysis, which has resulted in eliminating the inconsistencies that formerly existed between the theoretical stresses and the actual, measured stresses in structures of that type. Another one of his innovations was the artificial cooling of the concrete in Boulder Dam, a practice that has already been adopted for mass-concrete construction.

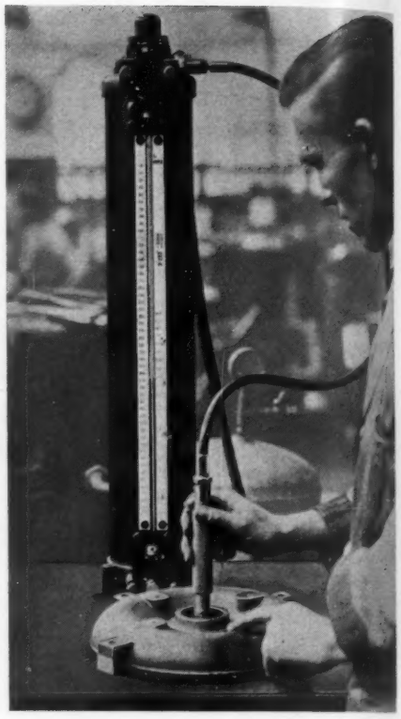
Naturally, such a busy life has left Mr. Savage little time for other pursuits, although he has never been known to refuse to lend assistance to construction engineers and contractors faced with special problems. His associates say that he ordinarily works fourteen hours a day. Aside from engineering, his greatest interest lies in helping young people to get college educations.

Air Gun Sprays Rubber Sealing Rings on Tin Cans

THE making of tin containers of all kinds for canning and merchandising foodstuffs and other commodities has reached a stage of efficiency that is nothing short of astounding. From the time the raw material is cut into blanks until the finished product is delivered at the discharge end of the machines, the numerous and varied operations are performed well-nigh automatically.

One of the newest adjuncts is an automatic rubber-coating apparatus that provides tops or bottoms of tin pails and other similar containers with a permanently affixed seal to assure air-tightness. The beaded lids are fed from a stack on to a rotating plate. As each lid turns, the rubber, which is in liquid form, is sprayed on to the edge by an air gun, which does not begin to function until the disk is properly spotted on the plate and closes the instant the latter has made a complete revolution. The quantity of rubber required depends upon the size of the tin top, and can be accurately controlled. Upon completion of the coating operation, the work travels for a predetermined period through a drying oven, in which a uniform temperature is maintained by means of a regulating device.

A machine of this description can apply seals to 8,000 lids from 6 to 8 inches in diameter at a power consumption of about 4.5 hp. After the containers are finished they are tested for tightness with compressed air at a rate of approximately 10,000 per hour.



Pneumatic Micrometer Checks Accuracy of Borings

THROUGH the courtesy of Laurence, Scott & Electromotors, Ltd., is reproduced the accompanying picture of a pneumatic micrometer which is being used in the company's Manchester plant for checking the internal diameters of ball-race bores on electric-motor end shields. The instrument has been in service for some time, and is believed to be the most accurate means available for measuring bore diameters on a commercial scale.

The work is done quickly by inserting into the bore a plug to which a compressed-air line is attached, the air admitted escaping by way of the annular clearance gauge which registers a difference in pressure. Because the plug fits freely in the bore it is subjected to little wear; and the air pressure does not affect the reliability of the micrometer. The scale of the gauge is marked in thousandths of an inch and gives direct visible reading. With the instrument it is possible to finish the bore and the ball race with equal precision, thus avoiding distortion both in assembling and running them. The micrometer is also being used by British automobile manufacturers, and is said to be well-nigh indispensable in the production of satisfactory ball bearings.

When Rock Crushed Rock

IN THIS modern era of efficient mining methods and equipment, few traces remain of the cumbersome, slow-moving machines—often homemade along rule-of-thumb lines—that were an integral part of mining practices as recently as the early years of the present century.

Coupled with the consistent advance in the science of ore extraction and the separation of complex ores has been the equally steady development in mining and metallurgical machinery. So much is the progress taken for granted, however, that it is only through the occasional fortunate discovery of a story-telling picture that we are afforded the opportunity to draw a parallel with the past.

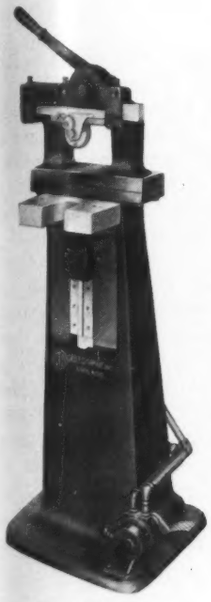
The photograph reproduced here is a part of the archives of the British Columbia Department of Mines, through whose courtesy it has been made available. It was taken in 1906, and shows an arrastre built by Joe Drinkwater, of Alberni, and Alvin Engvik, of Vancouver, at the Della property, Great Interior Basin, on Vancouver Island. In point of ruggedness, the region is similar to sections of the Andes.

This arrastre was erected in the hope that its crude grinding facilities, together with amalgamation, would make it possible to save the free gold that panning showed was present in the quartz outcroppings. It was operated by water power, details of the water wheel and the sluice leading to it being clearly visible. Although successful for a time, the apparatus had to be abandoned later when it was found that the quartz below the surface carried too much iron pyrites and too little free gold for satisfactory treatment by this method.

A PIONEER GOLD PLANT

An arrastre—the name is of Spanish derivation—was an apparatus for grinding and mixing ore by moving a heavy stone around upon it in a circular bed. It was often used as a crusher in lieu of stamps in isolated places. Free gold thus liberated from the rock was recovered by amalgamation with mercury.

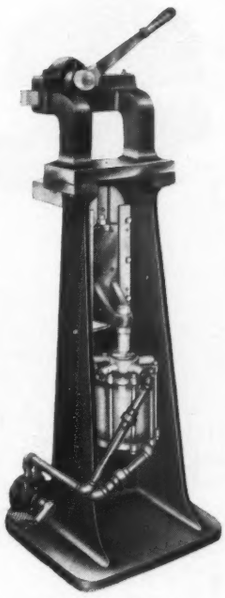
Adaptable Pneumatic Marking Machine



FRONT VIEW

BECAUSE compressed air is susceptible to nice control, and because it would serve to relieve operators of fatiguing work—all of which tends to increase production—Geo. T. Schmidt, Inc., has added a pneumatically operated model to its line of Hi-Duty marking machines. In Model 25 the customary foot pedal is supplanted by a 4-way foot valve and an air cylinder through which the work table is raised a maximum of 4 inches to the lettering tool. Air at line pressure is used, and varies from 30 to 100 pounds per square inch in accordance with the work—air at 75 pounds pressure, for example, resulting in a table pressure of 2,400 pounds.

The new machine can be supplied with a standard full table or with a slotted table for marking bar or shaft ends up to 4 inches in diameter and 36 inches long, and can handle rounds up to 10 inches in diameter and flats or irregular surfaces up to 4 inches thick. Because the air cushion is self-adjusting, Model 25 is well suited for the lettering and numbering of pieces that vary in contour and thickness, and it is especially recommended for continuous operation.



BACK VIEW

Keep Boiler Tubes Clean

ENGINEERS and plant owners that pay little attention to boiler scale, and there are said to be a good many of them, should profit by the results of an interesting series of tests made at the University of Illinois with locomotive tubes covered with scale ranging in thickness from zero to 1/9 inch. All told, 120 tests were made, and it was found that the heat losses varied from zero at zero thickness to 16 per cent with scale 1/9 inch thick. For one month after the boilers had been freed of scale, the output of the steam engines was 11 per cent greater than it had been during the three months preceding cleaning.

From this research work has been formulated the following rule, which will enable engineers to determine at any time the reduction in boiler efficiency attributable to scale: Forty-eight multiplied by the square root of the thickness of the scale is equal to the per cent loss. A curve plotted according to this rule will show that the loss increases rapidly when the scale is very thin and that the increase is not directly proportional to the thickness. It also indicates that after the scale is 1/9 inch thick the rate of loss diminishes—that is, added thickness at that stage makes little difference so far as heat loss is concerned.

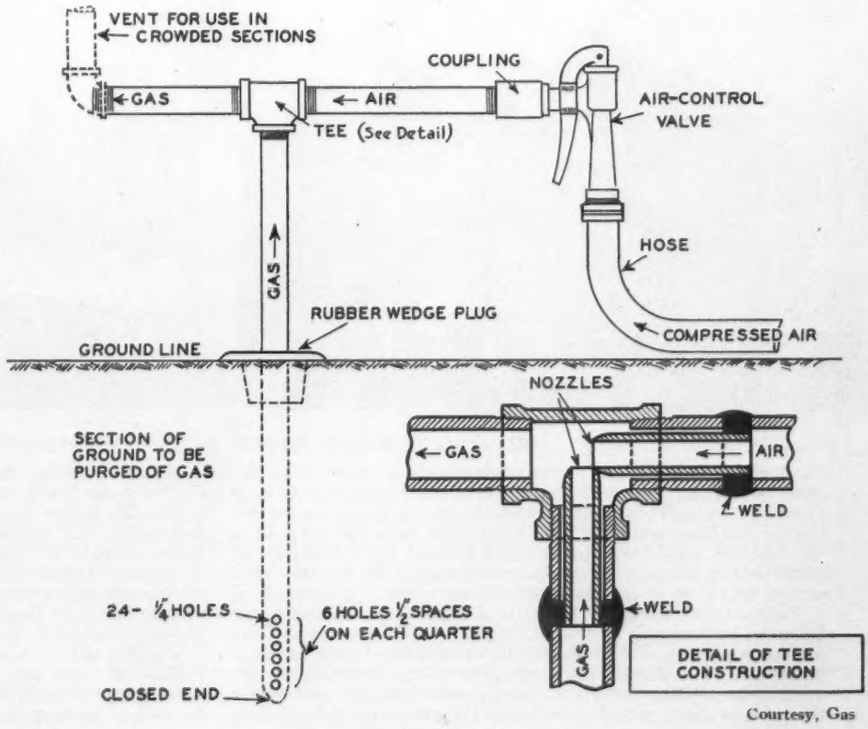
Compressed Air Purges Soil of Gas

IN COMPRESSED air, public-service gas companies have a very useful servant. It helps not only in the distribution of the gas but also in the laying and maintenance of the distribution system. In the latter department it has been given a new job, as brought out by the Central Hudson Gas & Electric Corporation of Poughkeepsie, N. Y., at the Eighteenth Annual Convention of the American Gas Association.

When bell-and-spigot joints of mains become leaky, it is the practice to apply a liquid seal on the inside. Each joint so treated has to be tested for tightness, work that has heretofore been hampered by reason of the fact that the surrounding soil retains for ten days and more a high concentration of residual gas. This, of course, makes it impossible to determine whether or not the joint has been properly sealed.

To clear the ground so that the maintenance men can finish their work without delay, there has been devised what has been called an aerator, which does the work by suction. The structural details of the equipment and its method of application are shown in the accompanying line drawings. Compressed air, supplied by a portable compressor, is admitted at the right, and as it rushes past the mouth of the nozzle at the top of the pipe inserted in the ground it sucks out the gas and carries it along with it to the discharge end of the ejector. The bottom of the pipe, which is closed to prevent clogging, is perforated circumferentially.

When first tested, two bar holes were put in the ground. Into one of these was poured peppermint and into the other was inserted the gas-ejector pipe. A few minutes after the air valve was opened, a group of men, who did not know what liquid had gone down the test hole, detected the odor of peppermint, thus proving that the ground had been purged. In average soil, an area of at least 100 square feet per hole can be effectually freed of residual gas by this method, so it is claimed.



Courtesy, Gas

Oil-Burner Blower Effects Savings in Operating Costs

TRANSFORMAIR is the name of a type of air-jet blowers manufactured by the New Jersey Meter Company for agitating liquids, for blowing forges, for operating gas furnaces and low-pressure oil burners, etc. They are designed to do for compressed air what electric transformers do for high-voltage current—that is, to take a small volume of high-pressure air and step it down or convert it into a large volume of low-pressure air.

Compressed air is extensively used for the aforementioned and other kindred purposes; but when it is taken from the line at 80 to 100 pounds pressure and reduced by a throttle valve to a few ounces there is a considerable loss in power. This loss is offset by the TransformAir which, under some conditions, is said actually to multiply the volume of air delivered as much as fifteen to twenty times.

The newest of the three models available is a high-duty, oil-burner blower, Type OBB, which differs from the forge and gas-furnace blowers only in size and structural features. Compressed air is supplied to a jet nozzle through a ½-inch needle valve which permits close control of the delivery pressure and volume. This high-pressure blast of compressed air induces a stream of free air and imparts to the latter some of its own velocity and energy. But before the air reaches the jet, it passes through a screen chamber which intercepts any particles of rust, pipe scale, or other foreign matter that might clog the small orifice of the nozzle. The blast tube or Venturi "horn" is a separate unit, and was made so

to enable careful machining and centering with the jet. Its proportions are such as to insure the best possible performance, and were arrived at only after exhaustive tests. A distinctive part of the oil-burner blower is the silencer on the intake. It is in the shape of a dome, and, in addition to eliminating the objectionable shrill, hissing noise otherwise given off by all but very small high-pressure jets, keeps dust and water out of the intake.

While no limits have been set as to the delivery pressure and volume possible with a blower of this type, a pressure of 2 pounds per square inch is considered high and a volume exceeding 200 cfm. should ordinarily not be expected of it. The volume of free air induced depends upon the delivery pressure and, under normal conditions, usually amounts to from 75 to 90 per cent of the total air requirement. It is free air in the fullest sense of the word, effecting savings in the cost of operating an oil burner that soon pay for the blower, it is claimed. The OBB, although it has been especially designed for use with low-pressure oil burners, has many other applications in connection with compressed air within the range of pressure and volume specified.

New Stope-Filling Materials and Method

FOR filling stopes, Noranda Mines, Ltd., Canada, is experimenting with a mixture of slag and pyrrhotite tailing, the latter oxidizing to a hydroxide of iron and serving to bind the mass. A test drift was driven through a stope that had been so filled, and after eleven months its walls were found to be so solid that they had to be drilled and blasted—picks made no impression on them. The material used was composed of 12 per cent mill tailing, 38 per cent crushed slag, and 50 per cent granulated slag.

The Sullivan Mine, in British Columbia, is resorting to an ingenious method in the case of large stopes on a very flat-dipping vein. At the low point in each stope is placed a concrete dam with provisions for drainage, and from the highest point a raise is run to waste passes connecting with the surface. Through these is introduced soil and gravel mixed with 20 per cent water, except where the grade is slight, when as much as 50 per cent is added. The material flows into all parts of the stope, filling it satisfactorily. It is believed that the mass will consolidate sufficiently to permit pillar recovery.

DRIVING GOLDEN RIVET IN GOLDEN GATE BRIDGE

On April 27, radio carried to the whole world the sound of an air-operated riveting hammer driving a rivet of gold to signalize the completion of the 4,200-foot-span suspension bridge across the Golden Gate in San Francisco Bay. Ed Stanley, who drove the first rivet in the structure, was selected for this final gesture. He is shown above about to start and with a microphone held nearby. In the right-hand picture the air required for the work is being turned on at a manifold.

The rivet, containing one pound of gold mined in California, was fashioned by its donor, Charles H. Segerstrom, of Sonora, Calif. Its driving, while symbolically successful, was a failure from a practical standpoint. The hammer had been made to forge steel and not soft gold. When Stanley turned on the compressed air, fine particles of the precious metal were showered upon the spectators, and the rivet refused to head up. It was subsequently replaced with a steel rivet.

The bridge was formally presented to the people of the state by Arthur M. Brown, Jr., chairman of the bridge commission, and was accepted by Mayor Rossi of San Francisco. Among the other speakers was Joseph B. Strauss, chief engineer, who had been in charge of its construction. Honored guests included: George Van Gorden, who crossed the plains on his way to California in 1846; J. H. P. Gedge, who sailed through the Golden Gate in 1849; Joseph Graham, the only remaining survivor of the group that witnessed the driving of a golden spike to mark the completion of the first transcontinental railroad 68 years ago; and three Chinese girls, whose grandfathers were imported to California nearly three-quarters of a century ago to work as laborers in the building of that railroad.

Industrial Notes

Vacuum-packed tea may soon make its appearance on grocers' shelves. Just like coffee, it is found to retain its original freshness—full flavor and aroma—better than when put up in the old way.

Work has been begun in Rome on Italy's first subway. It will be 4 miles long and will not only facilitate intercity traffic but also bring the Alban Hills and Ostia, Rome's seaside resort, within easy reach of the capital. The project is to be completed in time for the International Exposition which is to be held there in 1941.

From Cambridge, England, comes an interesting news item regarding the polishing of metals. To do a successful job it is necessary that the polish used have a higher melting point than the metal being polished. The explanation given is that solid metal even at room temperature will melt and flow a little when rubbed.

In business offices or departments where much figuring has to be done that does not warrant the purchase of a regular calculating machine, the checking of bills, costs, etc., can be facilitated by the use of a new vest-pocket adding machine—the Arithmometer. It adds and subtracts and helps to multiply and to divide, is said to be accurate, and costs only $2.50.

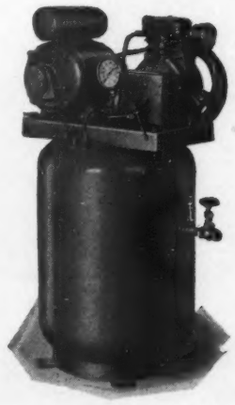
The Great Western Railway Company, England, is introducing a new type of freight car for the transportation of fragile commodities. It is subdivided by removable partitions that can be adjusted to accommodate shipments of varying sizes and to hold them firmly. Fifty of these cars are being built in the expectation that they will appreciably cut down loss resulting from breakage of goods in transit.

To neutralize acid in fuel oil for diesel engines, the Cunningham Company recommends the use of its new Dehydrator. This is a small cylindrical unit, and is interposed between the fuel tank and the engine. In the Dehydrator are five elements made of various metals which, when attacked by the acid in the oil, serve to neutralize it and thus prevent pitting and scoring of the inner surfaces of injection nozzles and fuel pumps.

Utah, which is a heavy producer of bituminous coal, is engaged in research work which, if successful, will benefit not only the industry but the country by and far. The State Legislature has appropriated $25,000 to test a process for the production of smokeless coal patented by L.C.Karrick, formerly connected with the U. S. Bureau of Mines. The experiments are being conducted at the University of Utah. According to the inventor, one ton of bituminous coal will yield a maximum of 3,000 cubic feet of gas, 36 gallons of crude oil, and 1,400 pounds of smokeless carbon, which is said to surpass the raw coal in heating value, to throw off but 1 per cent as much soot, tar, carbon, and ash, and to give a steadier and longer-burning flame. The cost of processing the fuel on a commercial scale is estimated at $1.25 a ton, and is more than offset by the by-products.

Colored aluminum, while nothing new, is being turned out in a plant in Birmingham, England, by a recently developed process that is said to mark an improvement in the art. The process is an electrical one whereby the protective coloring becomes an integral part of the metal, not just a surface deposit, and is permanent. Aluminum so treated, says *The Engineer*, London, will not corrode and is insulated against current up to 500 volts.

A new line of fractional-horsepower air compressors for small jobs has been announced by Ingersoll-Rand Company. The units are made in ¼- and ½-hp. sizes, have automatic start and stop control, an improved check valve, and are mounted on a new-style, seamless steel tank having a capacity of 18 gallons, except in the case of the ½-hp. compressor which can also be furnished with a 35-gallon tank arranged either in a vertical or a horizontal position. When designed for single-phase current, the machines are equipped with a brushless capacitator-type motor and a built-in automatic switch which gives overload and under-voltage protection. The new compressors have a rated discharge pressure of 150 pounds per square inch, are compact, neat in appearance, and are finished in opalescent brown.



V-AT2 COMPRESSOR

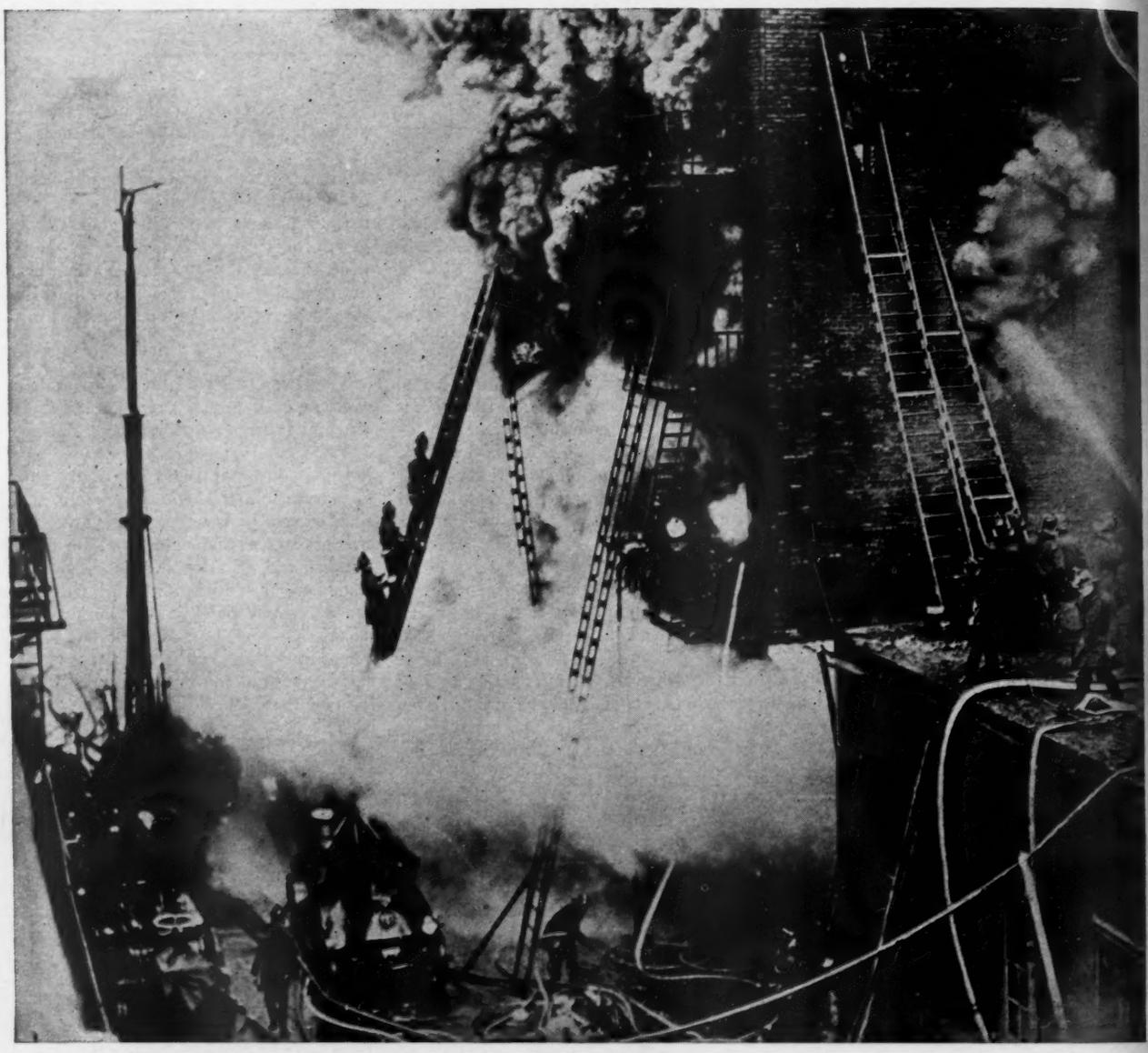
This ¼-hp. unit is 20⅛ inches long and, together with the tank, is 34⅜ inches high.

Spent fuller's earth, which is usually considered waste material, can be used instead of sand in the preparation of calcium-sulphate plasters. While lower in tensile strength than the sanded mixtures, the plasters are said to have greater workability; to cover a larger area; and, because of the small proportion of adsorbed hydrocarbons present, to be well-nigh waterproof. When fuller's earth is utilized for the purpose, the size of the particles, according to an authority of the U.S. Bureau of Mines, should be the same as that specified in the case of the sand.

The Direct Separator Company, Inc., well-known manufacturers of steam, oil, air, and other separators, has published a 33-page catalogue devoted exclusively to its direct internally and externally guided expansion joints. After a general description, each type is taken up separately, its special features delineated, and its characteristics and price listed. There is also included a rule and table by which anyone can determine quickly the amount of expansion in pipe lines of different metals. Those interested, can obtain a copy of the new Expansion Joints Catalog EJ-37 from the company which is located in Syracuse, N. Y.

With the aid of a new instrument, known as the defectoscope, it is said to be possible to determine the quality of metals up to 1 meter (3.28 feet) thick before they are put to use. It is the invention of a Soviet scientist, Prof. S. Y. Sokolov, and does its work by sound waves. In the case of a metallic medium, ultrasound waves are carried forward in the form of narrow bunches. Any air hole, crack, or other defect, however, will check their progress and deflect the waves. It is upon this characteristic that Professor Sokolov's device is based. It consists of a high-frequency lamp generator, a quartz anode, a quartz cathode, and a receiver. The defectoscope is compact and easily portable.

For the removal of soot from heating surfaces, Harco Chemical Company is offering a powder that is burned with the fuel. It is introduced into the combustion chamber of an oil-burning installation or, in the case of coal, is either added to it as it is being fired or is scattered over the bed. The chemical action set up by the preparation is said to provide the soot with sufficient oxygen to enable the hot gases to ignite and burn it from heating surfaces that cannot be adequately cleaned or that cannot be reached by mechanical cleaning devices. Upon first application, the manufacturer recommends that for every 100 hp. a maximum of 5 pounds of the powder be used per day for five days, and after that approximately 1 pound daily. The chemical is sold in quantities of 50 and 300 pounds packed in steel containers. It is claimed that boiler surfaces and refractories in their setting are not attacked by it.



WATER—OR SUDDEN DEATH

A typical example of Goodrich improvement in rubber

WHEN the four-alarm sirens scream, lives and millions depend on split-second action.

Count on the engines to be there in a flash. But in lugging heavy hose from hydrant to fire, and up into the burning building, vital time is lost.

Every hose manufacturer has tried to cut that time by making hose lighter, easier to handle—but the only way they could do it was to use less rubber or cotton jacket, and the result was such a loss in burst strength that the hose was not safe, or impractical because it weakened too soon.

Then Goodrich engineers went to work on the problem—the same engineers who doubled belt life with the raw-edge belt and Plylock Splice—who speeded construction with air hose that doesn't clog tools—who found how to attach rubber to steel and make modern acid handling possible—these engineers who have developed a thousand improvements for industry now set to work on fire hose.

First they invented a new kind of cotton cord of greater strength. They found a new rubber compound which in thinner gauge is as sturdy as previous rubber of greater thickness. Then they developed a method of weaving the cotton jacket, using more but smaller strands and twisting them the way ship cables are spun so that each strand carries its equal share of pressure.

The result is Highflex Fire Hose—a hose equal in burst strength—equal in every way—to other hose, yet 18% lighter and easier to handle . . . a long step forward in the battle for life and property . . . another plus value for industry, added by Goodrich research. The B. F. Goodrich Co., Mechanical Rubber Goods Division, Akron, Ohio.

Goodrich

ALL *products problems* IN RUBBER